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Mobile Radio Technology

The journal of mobile communications technology

Installation and Maintenance Issue

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- Remote control adapter
- Choosing bypass capacitors
- Reflected power measurements
- Customer service tips

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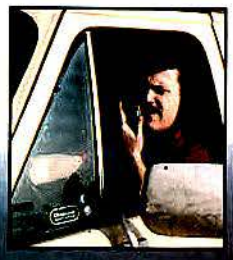

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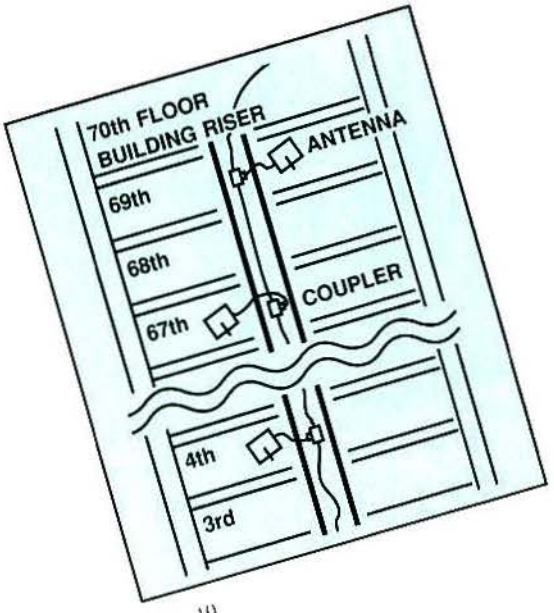

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features

On the cover: Matthew P. LaCourte, general manager of Bay Area Service Center, Santa Clara, CA, at his company's work bench designed for servicing portable two-way radios.

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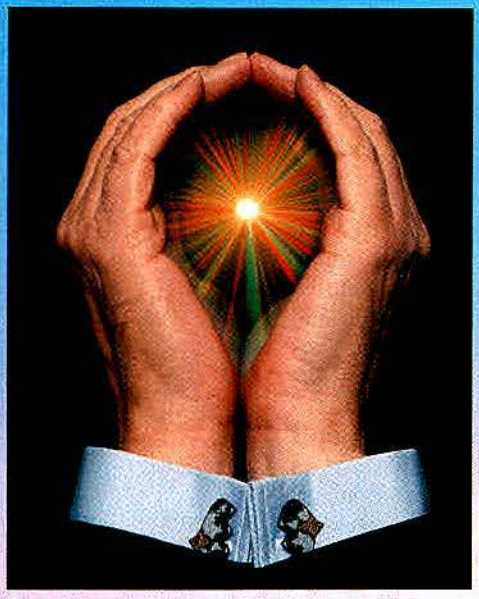

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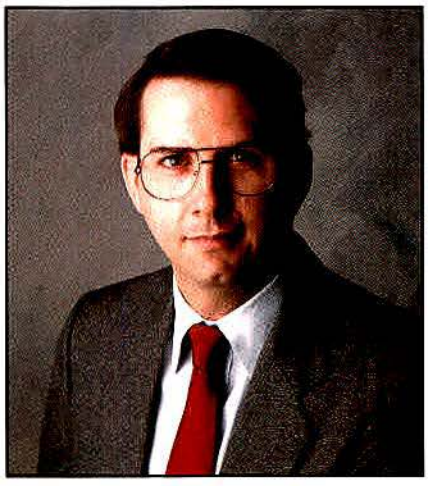


Digital standards

Ericsson GE demonstrated prototypes for time division multiple access (TDMA) digital trunked radio communications equipment at the Associated Public-Safety Communications Officers' (APCO) national conference Aug. 10-14 in Seattle. At a previous APCO conference, Motorola unveiled its plans for frequency division multiple access (FDMA) digital public safety radio, but no prototypes.

These manufacturers' actions are worth noting because the digital standard for public safety radio has not been completed. It is being formulated by APCO, the National Association of State Telecommunications Directors (NASTD) and representatives of radio users within the federal government.

The Project 25 committee already selected FDMA as part of the standard. Thus, Ericsson GE's TDMA equipment might be offered outside the standard, or the committee might reconsider its earlier choice.

Standards help to resolve at least two requests that are common to many radio users: that equipment should be available from multiple vendors and that they should be able to communicate freely using equipment from different vendors.

Multiple sources help to keep prices lower because of competition and to stimulate new feature development. Compatibility allows radio users in different jurisdictions to communicate with one another when necessary.

Despite the good reasons to have standards, some customers do not want to wait or cannot wait for standards before they buy equipment to satisfy communications requirements.

Thus, while manufacturers participate in standard-setting proceedings, such as Project 25, they also move ahead to serve customers who want equipment right away.

Efficient use of existing resources and international competition motivate manufacturers, too.

Ericsson GE made extensive use of its TDMA cellular mobile telephone technology in constructing its prototype equipment.

European and Japanese manufacturers, among others, may be expected to serve the digital radio market too. The need to win and keep a large enough market share to succeed in the worldwide market is another force that pushes manufacturers to introduce products before standards are finished.

We do not know which group feels more pressure, the manufacturers' product managers or the Project 25 committee members. But the sooner the standard is set, the more power it will have to shape digital public safety radio product development.

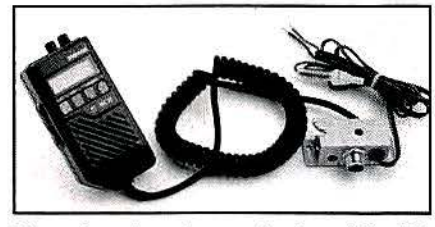
* * *

Microphone mobile

Miniaturization that allows CB mobile transceivers to be built into microphone-sized housings is impressive.

Portable transceivers have been contained in ever-shrinking packages. Maybe it was just a matter of time before a mobile transceiver was built into a housing as small as some portables.

One reason for building a transceiver into a microphone housing is the shape of the modern automobile interior. As automobile interiors have become stylized and sculptured like a cockpit, the space available to install an underdash transceiver has diminished or virtually disappeared.



Maxon's microphone-sized mobile CB transceiver.

Hobbyists sometimes choose their vehicles to fit their radio equipment. Public safety and industrial radio users generally do not have that choice.

With miniaturization such as the microphone-sized transceiver, the dashboard part of the installation boils down to finding a place for the mic clip.

—Don Bishop

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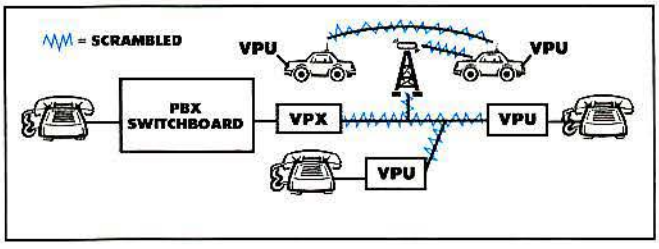

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Letters to the editor

Radio coverage design:

I am afraid Herb Sachs' July 1992 letter to the editor drew the wrong conclusion from my February 1992 "Radio Coverage Design and System Optimization" article.

[*The letter summarizes Mirza Ahmad's article as suggesting that the problem of coverage prediction is so complex that it justifies forgoing detailed analysis of radio communications reliability and making major performance decisions using shadow plots and non-terrain dependent propagation analysis. —ed.*]

In an apparent contradiction, the letter reiterates (with a little twist) the same good propagation engineering practices the article actually discusses.

The article makes clear that "real-world propagation" is not real when field variables are estimated incorrectly. A real-world propagation analysis under such conditions is wrong.

If true field conditions (some the article mentions) are not estimated accurately, then the cumulative error due to a large number of wrong assumptions becomes so large that one might as well forgo this step, i.e., predicting real-world coverage in the *preliminary* system design stages.

The preliminary design stages' purpose simply is to eliminate sites. This purpose is where "shadow plots," which are terrain-dependent line-of-sight graphic displays, come in cheap. One need not be an RF guru to read these plots, which basically show how different sites compare from a coverage perspective.

If, on the other hand, the client chooses to differ with this sample approach, even during *preliminary* system coverage design, then one should insist on the most accurate available coverage prediction by using all "site-specific" variables as accurately as possible. Just because statistical data are available for different variables does not mean they always are applied accurately.

Once the potential site list has been narrowed to a few desirable sites, a more thorough propagation analysis makes more sense because many of the RF hardware specifications, such as transmitter, combiner, cable, connectors and antenna, are derived from the propagation analysis results.

Another reason for writing this article was to provide information to the end-user on some radio design pitfalls and to bring attention to the following:

1. Over-designing a system (a common practice) does not require a specialist.

Even a novice can design such systems. One does not need a specialist to specify the most powerful available transmitter, the highest gain antenna or the tallest available tower. Over-

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The journal of mobile communications technology

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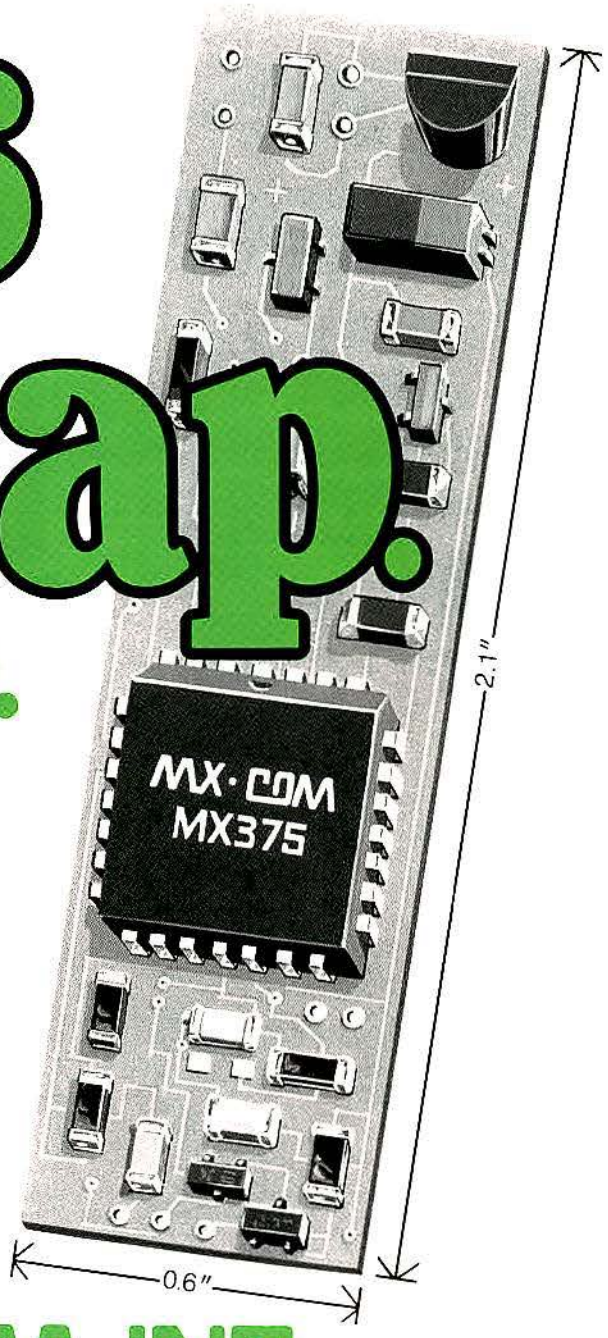

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designing increases the interference potential to others and increases frequency reuse distance.

2. Over-designing costs more, both in hardware and power consumption, and therefore, this practice strongly should be discouraged.

Radio coverage contours are becoming more interference-limited rather than noise-limited. The days of high effective radiated power (ERP) sites are over.

3. System design verification almost always is required via signal strength measurement, which sometimes shows extreme variations between predicted coverage and the actual test.

In turn, these variations may require major design adjustments, including adding a new site in some cases. (Refer to the article to see why this situation happens.)

4. Most of the time, the available site choice is so limited (sometimes to one or two) that there are only one or two ways to design the system.

A shadow plot provides a comparative analysis of the sites in such instances.

5. Certain radio designs are indeed trivial for the experienced radio operator, and as can a common cold, they can be handled well by in-house talent.

Mirza Ahmad
Senior Engineer
SFA
Landover, MD

Tower lighting:

It is comforting to know that technology has progressed into the realm of tower lighting ("Using White Lights To Mark Radio Towers" by Lew Wetzel, June 1992 issue).

This is especially true concerning the white strobe variety. White strobes on small towers that are well below and many miles from a flight path can be particularly distracting for a pilot.

The new design of white strobe beacons should certainly be welcomed by pilots. Its narrow beamwidth should reduce the unwanted distraction of beacons unnecessarily demanding attention.

When a tower is near my flight path, I certainly want to know about it. When it is not near my flight path, my attention is needed elsewhere.

Please understand that any blinking white light in the blackness of night can be seen for miles and must be studied to make sure it is not an approaching aircraft.

Unlike red beacons, white strobes can give especially deceptive distance recognition. Thus, reducing the amount of white strobe clutter being projected upward into the sky should be helpful.

W. Spade Condry
Telecommunications Technician
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Engineering in-building RF coverage systems

Overcome coverage problems in buildings and parking garages by using booster transmitters, leaky coaxial cable or distributed antennas. Field surveys help to define the problem and point to the best solution.

By Valdur S. Kaunismaa, P. Eng.

Ever-increasing use of personal pocket radios by public safety agencies and the general public appears to have its roots in cellular mobile telephone development. The idea is that your personal communications device goes with you, rather than staying in your car, home or office.

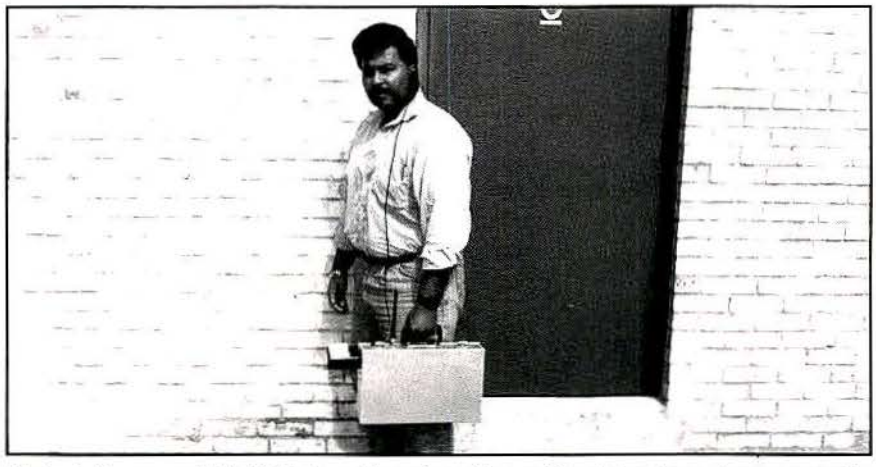

Photo 1. Use a portable field strength meter with a calibrated antenna to measure the existing base station's received signals within the building and on the roof or top floor.

Extending coverage into some buildings can challenge those who design and operate radio systems. Most people spend considerable time indoors, and they naturally expect that their communications devices will work flawlessly wherever they go.

Nevertheless, in many large office complexes, in large shopping malls and, in almost every case, in underground shopping concourses and parking garages, radio signals from base stations do not penetrate well enough.

In a large office complex, two-way radio communication usually is possible near windows and in offices along the exterior wall, but it is more difficult or impossible at the building core. Signal attenuation in offices along the wall may be 15dB to 20dB, and as high as 30dB to 40dB at the building core.

Kaunismaa is president of Kaval Electronics, Markham, Ontario.

Expectations

Users normally expect coverage in buildings as part of the system design. When a system designer identifies buildings where coverage may be poor or lacking, then users commonly expect a low-cost solution.

"Why can't we use a passive repeater?" users sometimes ask.

In this context, a passive repeater is an antenna outside the structure connected via coaxial cable to an antenna inside the structure. This solution succeeds only under favorable conditions and for a small coverage area.

Stories abound about paging system operators who insert consumer-grade TV signal amplifiers near the external antenna to boost the coverage near the internal antenna with successful results.

Some end-users claim one frequency band is superior to another for building penetration. Observations reveal that the propagation methods that lead to this conclusion are conduction via power lines, actual loss through walls, waveguide effect along corridors and reflection and refraction peculiar to each frequency band in a given building. Thus, a general conclusion about one frequency band's superiority cannot be drawn.

"We use a special frequency that penetrates steel and concrete effortlessly," claims a paging company's advertisement printed a few years ago in several airlines' magazines. Cellular carriers would pay millions of dollars to find out what this secret frequency is.

Survey

If the coverage problem is extensive and results must be guaranteed, conduct a physical survey to define deficient areas and typical building losses. The survey lays the groundwork for planning the solution.

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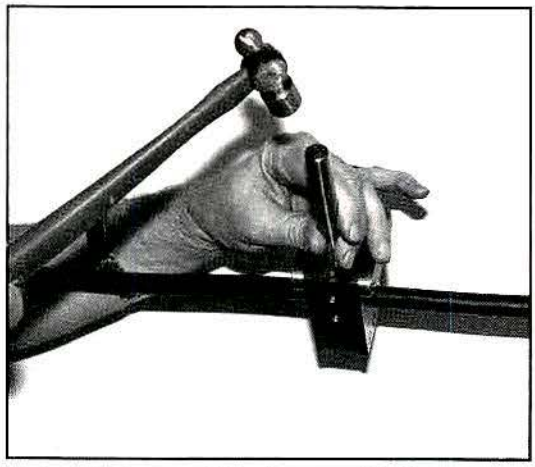

Photo 2. Using special tools, an unskilled person can tap the cable by punching an access hole without actually cutting the cable.

Providing reliable in-building coverage begins with a survey to define where coverage is lacking and to define how much and where radio energy is absorbed by the structure. The survey establishes building losses measured in decibels. Then a subsystem can be designed that relies on existing coverage where it is acceptable and fills in the coverage where it is deficient.

To conduct a survey, use a portable field strength meter with a calibrated antenna to measure the existing base station's received signals in the building and on the roof or top floor. (See Photo 1 on page 10.)

To plan the subsystem needed to fill in the radio coverage "holes," configure a portable radio to act as a base station. Use a portable radio of known RF power to feed a calibrated whip antenna on a ground plane. Alternatively, a portable with known antenna performance can be used. Be careful, though, because some uncertainty is introduced by the body's absorption of RF, among other factors.

With the "portable base" station positioned in strategic locations and transmitting, measure and record the received signal level in the surrounding area.

Use the field strength meter to measure the existing base station signal on the roof, too, and to scan for other radio signals near the desired operating band. These data are useful for the final system design to know the off-the-air signal strength. The path loss to the base station can be calculated, as well as the signal strength required for the portable to reach the base station.

Use the "portable base" station's output power, antenna gain performance and cable losses to calculate path losses to the various offices and corridors.

Typical offices and shopping areas in the building can be tested to learn the general structural losses without surveying each floor. As a rule, an antenna on one floor provides coverage on that floor and the floors immediately above and below.

With complex structures, use the architectural plans to help with final installation planning.

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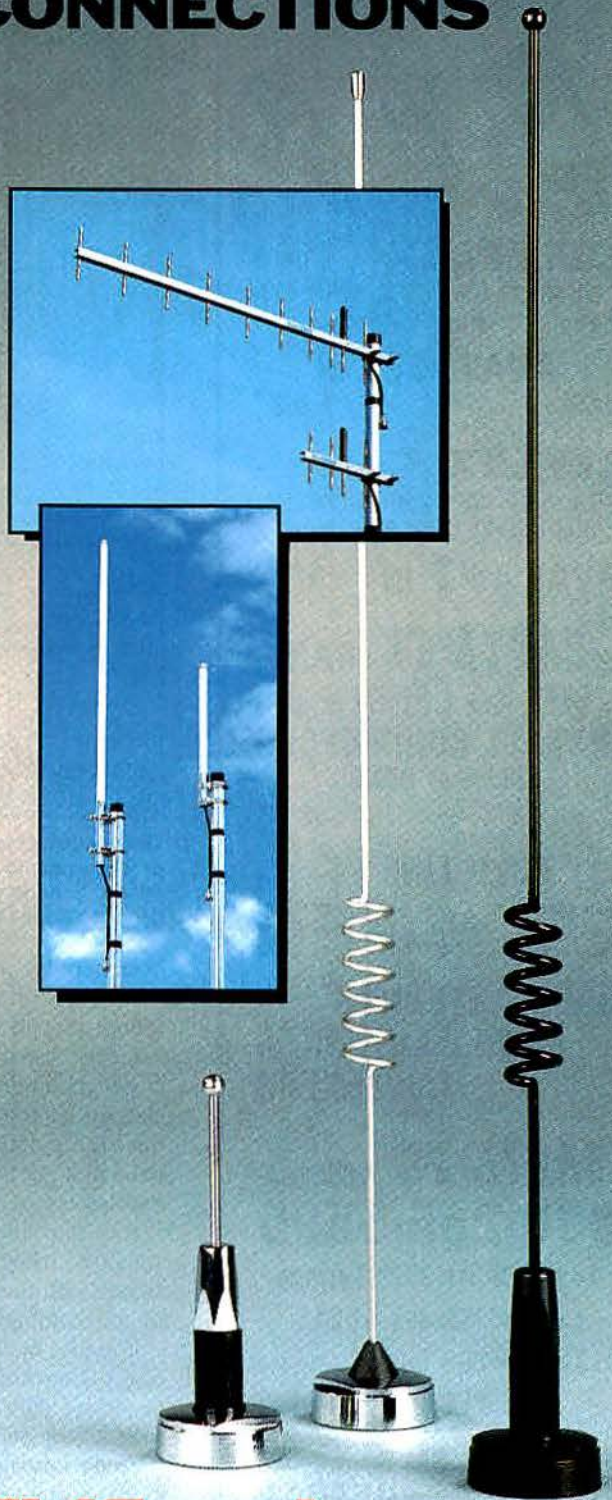

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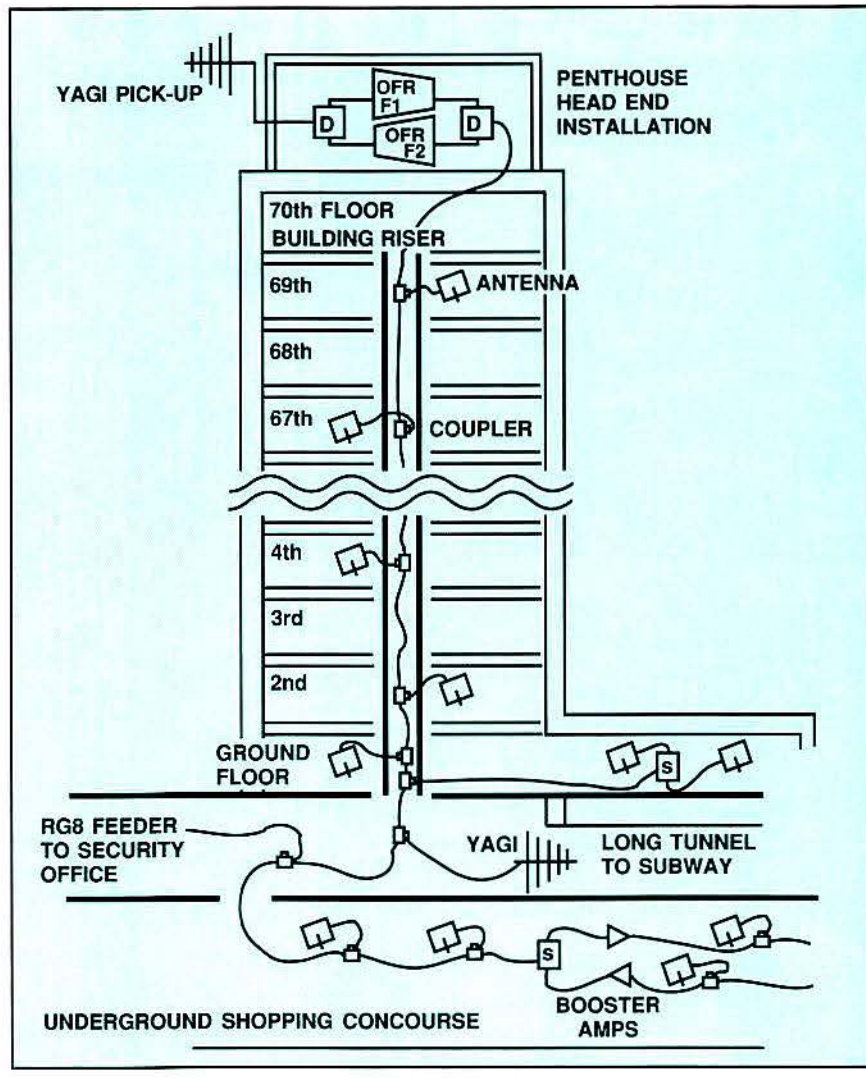

The head end can be a combination of VHF, UHF and 800MHz systems. In this example, provision could be made to accommodate paging companies, police, fire and maintenance. Ground plane, low-profile, or directional antennas can be used. Booster amplifiers can be installed to increase the coverage area.

Generally, modifying the building exterior or environment to improve indoor reception can be ruled out.

Using leased telephone lines to carry communications to indoor fill-in base stations is too expensive. Moreover, this configuration causes distorted signals that garble communications in overlap areas.

A better solution is to receive reasonably strong, existing base station signals off the air and amplify them for in-building retransmission.

Usually, the best reception is on the roof. The rooftop reception quality is measured during the survey.

➤ *Common booster*—One way of keeping costs down is to use a common booster amplifier to rebroadcast all the channels through a single, low-cost amplifier.

Wideband Class A amplifiers used for such purposes typically have a 500MHz bandwidth. Input and output RF filters must be used to narrow the response.

Unfortunately, the RF filters cannot discriminate against unwanted signals that may happen to fall between the desired operating channels.

Both unwanted and wanted strong signals within the bandwidth cause intermodulation interference. All signals, whether strong or weak, are amplified by the same fixed amount, typically 60dB to 70dB. The existence of unwanted strong signals within the bandwidth is revealed by the survey

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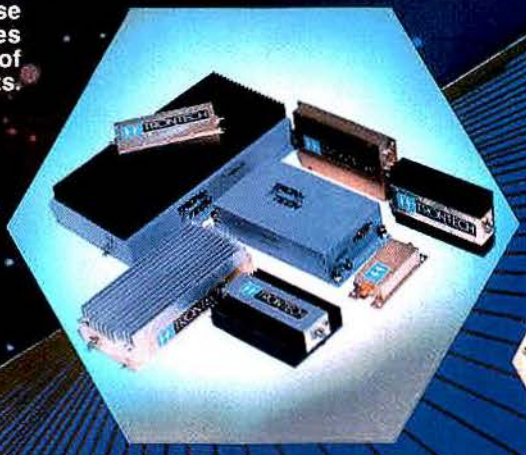
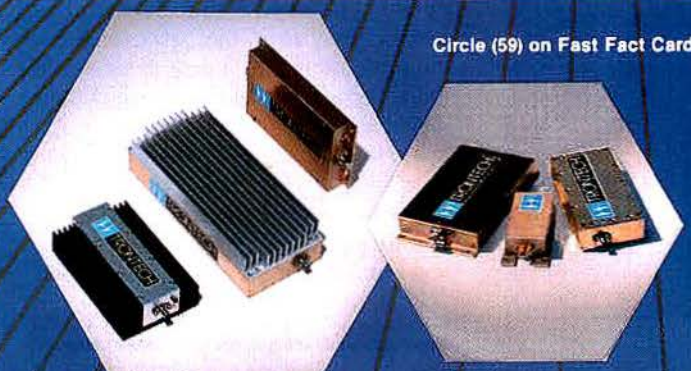


Product Area	Freq. Range	Description
Low noise	10 — 4200 MHz	Noise Figures under 1.2 dB for superior receiver sensitivity
Wide dynamic range amplifiers	400 — 1000 MHz	Low noise amplifiers with typical gain under 20 dB and 3rd order intercept points greater than +35 dBm
High power linear	400 — 1000 MHz	Amplifiers up to 80 Watts Linear for transmit applications
High power linear	1.7 — 2.3 GHz	GaAs Power Amplifiers for Cellular Radio Microwave Links



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measurements taken on the roof.

FCC rules require that the maximum booster output level for multichannel units be reduced such that unwanted signals are limited to −43dBc, which in turn hampers their effectiveness.

Moreover, paging system operators may object to a wideband design because it may help their competitors' signals as much as their own.

Thus, the wideband solution has to meet a stringent set of requirements to be the right solution.

➤ *On-frequency repeaters*—An alternative for frequency-congested areas is an on-frequency repeater (OFR) that can intercept and process off-the-air radio channels individually, rejecting all others, and providing a constant RF output regardless of input signal.

With the pickup sensitivity set at maximum, the OFR can provide as much as 127dB gain. This much gain may not be required or useful. Thus, the OFR input pickup sensitivity or output power can be adjusted to fit the requirement.

A 5W-per-channel device, the OFR can be multicoupled with low-cost mobile duplexers and low-cost ferrite devices not normally used in two-way radio base stations.

Both the wideband and OFR designs work best when they receive a strong, reliable base station signal to minimize feedback. Thus, a directional gain antenna should be used to receive the base station.

One word of caution: In a large city, a 10dB gain antenna does not necessarily deliver 10dB gain. Multiple reflections may obliterate the expected gain. In such an environment, a whip antenna may work better, or the gain antenna may have to be pointed at a reflected signal at some angle to a direct line with the base station. This observation is particularly true in the 800MHz-to-900MHz band.

Distribution network

To design the in-building RF distribution system, use the building structural losses measured during the field survey. Take into account the portable radio's RF output, antenna and body loss and the minimum necessary received portable input level for reliable communications.

Use this information to determine the required radiated power from the indoor antennas and the maximum allowable losses from the portables to the off-the-air head end equipment.

Important factors such as body loss at the head level vs. a hip-mounted portable and the type of portable antenna make a difference in the minimum necessary signal level. A hip-mounted portable with a short, stubby antenna may form the basis for minimum requirements. Voice pagers need the highest signal level because of their inefficient antennas.

➤ *High-power OFR*—One approach is to fill in the coverage hole using a single in-building antenna with 1W RF output per channel. The 1W power level allows for path losses of 120dB

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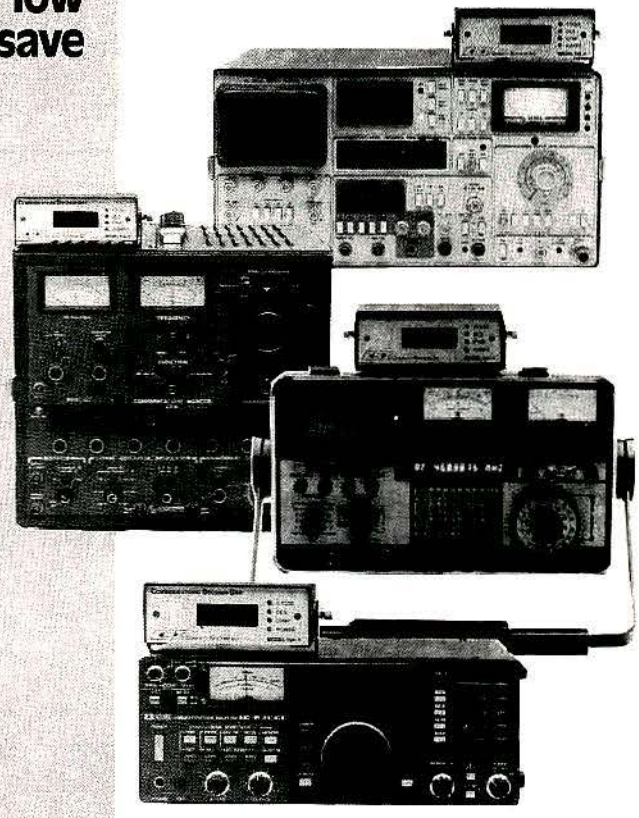

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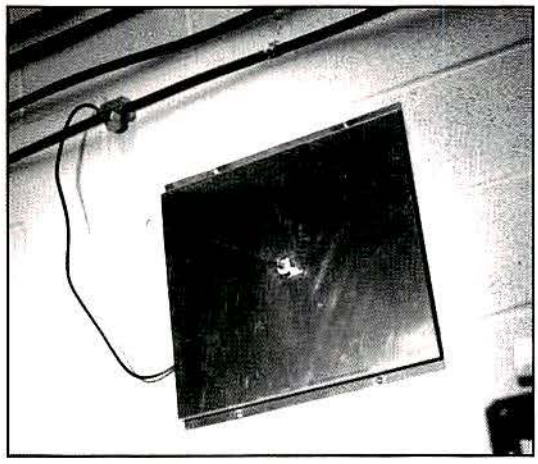


Photo 3. To support more than one RF band, a simple whip antenna that serves VHF, UHF and 800MHz frequencies has been developed.

for a typical area and can fill the entire area of deficiency in a large shopping mall.

This technique may not work in a multistory building with underground facilities.

A serious concern is that broadcasting all the power from one antenna may cause self-oscillations if the receiving antenna picks up the rebroadcast signal.

➤ *Leaky cable*—Another approach is to use leaky coaxial cable to distribute the booster power throughout the desired area.

This method can be somewhat expensive because brand-name leaky cable is costly. Any poorly shielded cable, such as low-cost RG-58 or RG-8 cable, can be used.

Moreover, the off-the-air devices have limited power, and after a typical leaky coax coupling loss of 70dB, there is not much signal left to penetrate walls. To overcome the short coverage range, the leaky coax must be routed through an extensive maze of offices and corridors.

Leaky coax relies on surface wave coupling, which means a more effective, yet simple, whip antenna increases the received signal 25dB to 35dB, depending on how far the receiver is from the leaky coax and a similarly positioned whip.

➤ *Tapped distributed radiator*—To overcome the problem of short coverage range and to control RF feedback effectively, the best solution may be to use low-cost cable television (CATV) cable to feed numerous whip antennas on ground planes.

For this purpose, a low-loss feeder cable is routed along a central feeder to the shielded area, and RF is coupled to and from the feeder as required. Each antenna tap can feed a local whip antenna or one remote antenna using low-cost RG-58 cable.

The first advantage is that 0.5-inch cable such as Trilogy MC^2 .500 and Comm/Scope QR540 (for which antenna taps are available) costs less than $1 a foot.

The second advantage is that basic feeder losses are low. Typical losses per 100 feet of cable are:

FREQUENCY	LOSS
150MHz	0.8dB
450MHz	1.4dB
900MHz	2.1dB

The third advantage is that taps in coupling values from 12dB to 30dB insert an in-line loss of 0.6dB (for 12dB coupling) to 0.3dB (for 30dB coupling). This loss is much lower compared to the traditional way of cutting the cable and adding a power splitter, which carries a loss of 3.5dB.

The fourth advantage is that, to install each tap, an unskilled person can punch an access hole with special tools without actually cutting the cable. (See Photo 2 on page 12.)

The real advantage to the design engineer is complete control of the radiation characteristics.

If the system is designed for tapped antenna distribution and you find a coverage deficiency, just punch in a new tap, add a new antenna or run a long cable to the problem area.

Alternatively, when a tap is found to be unnecessary, the block can be rotated to cover the mistake, or the tap's coupling value can be changed.

The basic idea of the tapped antenna design is to take low-level RF close to the area where coverage is required, rather than wasting it on penetrating walls and other obstructions. It is amazing how far a 1mW radio signal reaches from the right location.

To support more than one RF band, a simple whip antenna that serves VHF, UHF and 800MHz frequencies has been developed. (See photo 3 on page 18).

Using solid-shield cable keeps RF from leaking where it does no good. Thus, the distributed system maintains control over RF emission.

Feedback to the pickup antenna is, in most cases, eliminated when milliwatts rather than watts of power are used. In fact, the 30dB advantage of 1W vs. 1mW can be lost in a short distance if a wall must be penetrated.

With such low-cost feeder, it usually is cheaper to run separate transmit and receive lines than to multicouple.

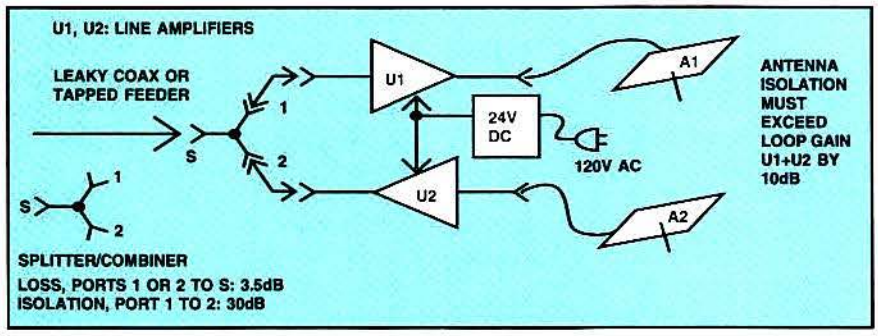
Because a transmission eventually turns into a reception, confusion can be avoided by referring to *talk-into-building* (TIB) and *talk-out-of-building* (TOB) communications.

TIB and TOB isolation is achieved by separating the two antennas. The dual feeder makes it easy to add simple in-line amplifiers to boost signals.

Because of previous training, most RF engineers are inclined always to provide a common TIB and TOB feeder. With a brand-name leaky coax, it is necessary that TIB and TOB share the feeder because of the expense.

With a common feeder, when amplification is needed, complicated bidirectional amplifiers are required. Unless a detailed analysis of actual levels, frequencies and intermodulation products is conducted before using bidirectional amplifiers, they may spring some unpleasant surprises on an unsuspecting user.

Such a surprise may be the triggering of receivers by unexpected



intermodulation products.

Remember, when conducting an intermodulation analysis, consider the possibility of portables inside the building acting as transmitters. In addition, with separate TIB and TOB feeders, it is not necessary to support a 100dB dynamic signal range with its corresponding potential for intermodulation problems, as is the case with bidirectional amplifiers and multicouplers that generate intermodulation.

A concept that works with any common TIB and TOB feeder that runs out of power is to use a hybrid splitter to separate the lines and to add line amplifiers as shown in the figure above.

Some radio engineers do not like the idea of using 75Ω CATV cable. One reason for using it is that with 75Ω CATV feeder, the antenna tap outputs are 50Ω.

For those who insist on using 50Ω cable, there is a source of low-cost 50Ω CATV-type cable. And 50Ω-to-75Ω transformers are available from several suppliers.

The philosophy for RF coverage extension design in summary follows:

1. Define the exact nature of the problem.
2. Conduct a careful field survey.
3. To guarantee long-lasting success, use single-frequency selection signal extender technology.
4. For large buildings, use a tapped CATV-type distribution system.

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Build a remote adapter for Radius M100 radios

Use an IC, a transistor, five resistors and two capacitors to build an adapter for remote channel selection. Then the M100 can serve as a low-cost remote base, as a backup unit or as a disaster command center.

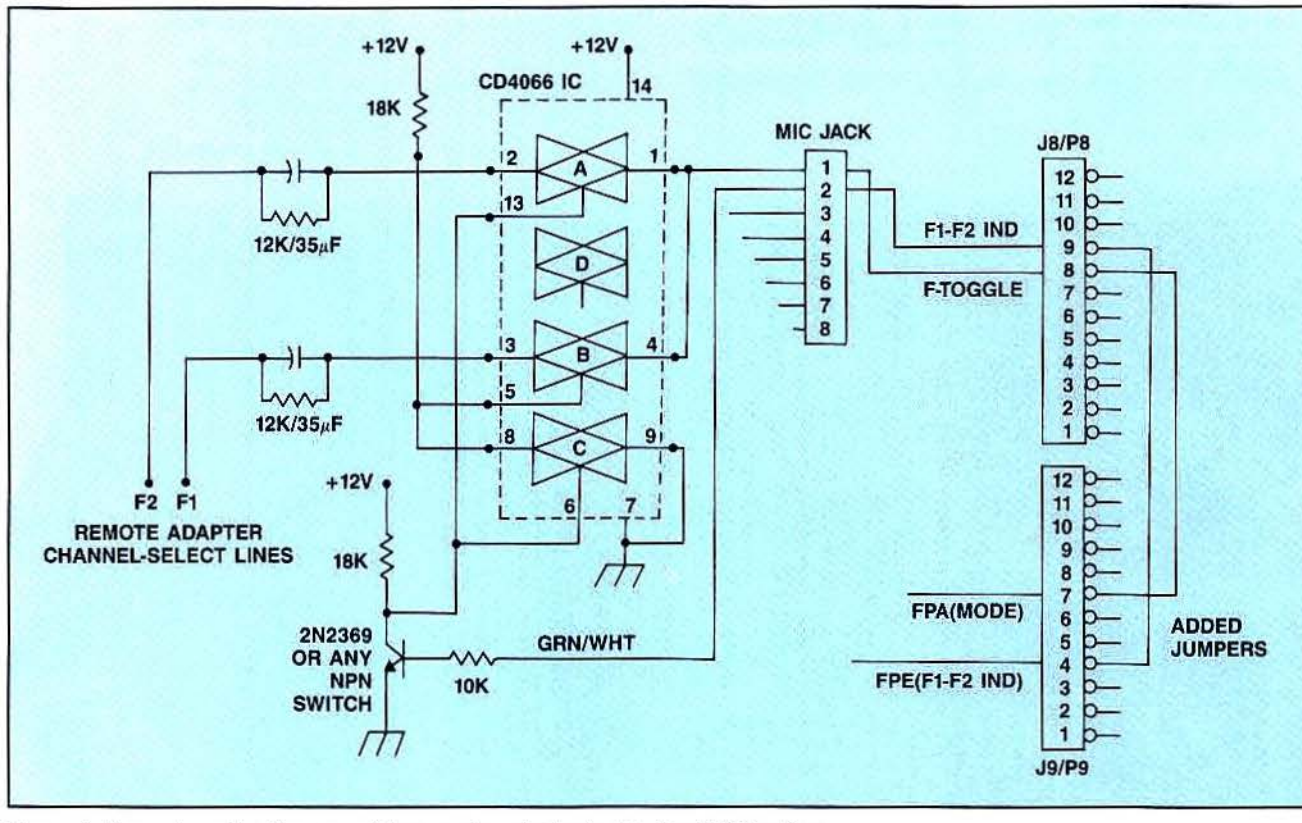

Figure 1. The schematic diagram of the remote adapter for Radius M100 radios.

By Larry R. Antonuk

Motorola's introduction of Maxtrac-Radius products in the late 1980s ushered in a line of dash-mount radios that are programmable, reliable, easy to use and available with a variety of options.

Antonuk is a project manager for R & R Communications, a Motorola service shop in Keene, NH.

The products meet many requirements for users and technicians alike. Scan functions program easily into the units. Various connection points for extended local control are wired to the rear panel, making the radios useful as base stations.

The radios' reputation for reliability has led to their use in more and more applications, such as RF links, scanning monitor receivers and telemetry systems. Most of these applications require minor modifications to the radio, but Radius units have proven flexible enough to allow slight "improvements." Perhaps the only function that has caused some difficulty is the use of the radio as a low-cost remote base.

The problem

Small companies in northern New England often need radio coverage over a large area, and they use two community repeaters for that purpose. Thus arises the need for a low-cost base station that operates on two channels.

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- *Bench quality...field portable*
- *Microprocessor controlled*
- *Memory storage*
- *Battery operated*
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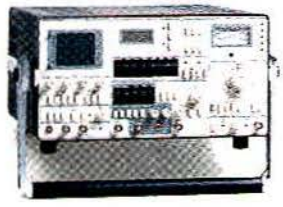

D. *Model CT3000S*

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- *Modular construction*
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The Radius M100 is an ideal candidate. All necessary connections for remote operation are available at the mic connector, or they can be wired to it. Converting the base station has not been difficult because any aftermarket tone or dc adapter works for remote operation. The problem occurs in adding remote frequency selection.

Tone and dc remote adapters are designed for radios with crystals, or at least radios with discrete (one-of-eight) channel-select lines. The typical remote adapter changes channels via a sequence of events: The monitor relay closes, followed by the closing of the proper channel-select relay to pull the channel-select line low, followed by the closing of the push-to-talk (PTT) relay. When the PTT relay closes, the channel-select relay stays latched in position until it is commanded to change channels.

The sequence works fine for crystal radios, but the M100 lacks discrete channel-select lines. There is no connection in the radio to control the function of changing the transmitter from one channel to another. To change channels on the M100, the operator presses the MODE button to toggle the channel as indicated by F1 and F2 light-emitting diodes (LEDs) on the front panel. Correct channel selection depends on visual feedback to the operator.

Toggling the channel

The frequency selection problem has two parts, toggling the channel and keeping the remote control and the base station in step.

First is the problem of converting a continuous, low potential from the remote adapter's channel-select relay (formerly used to ground a channel element) into a momentary MODE pulse that toggles the channel.

To make the conversion, use the parallel resistor-capacitor (RC) combinations at the F1 and F2 inputs. See Figure 1 on page 22. A ground at either of these inputs will affect the F-TOGGLE point until the capacitor charges to the MODE potential. (The parallel resistor is a bleeder that discharges the capacitor before the next F1-F2 transition.)

Adding the four components is all that is necessary to allow the remote adapter frequency-select grounds to pulse the MODE switch.

For instance, repeated transmissions on F1 cause the F1 relay ground to stay low, so the radio frequency will not change. Changing the channel via the remote's F1-F2 switch toggles the ground from the decoder, which pulses the MODE line and changes the radio to F2. The radio channel follows the remote adapter's frequency-select relay. Everything works as expected, at least on the bench.

Keeping in step

With the use of the RC circuits only, channel agreement between the remote control and the base station is completely arbitrary. A power failure or missed command puts the base and remote out of step. The user has no way to correct the situation. Thus, the second problem

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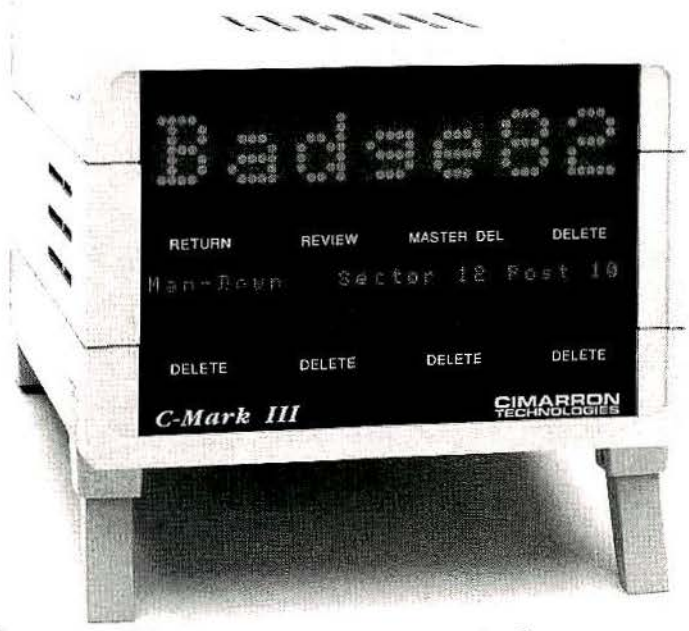

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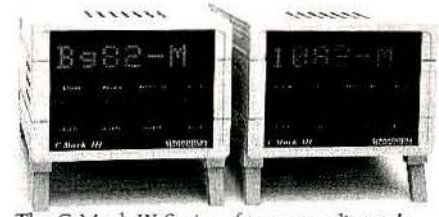

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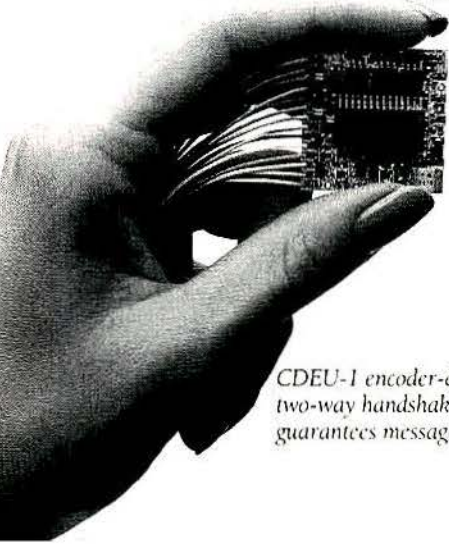

CDEU-1 encoder-decoder features two-way handshaking protocol that guarantees message reliability.

Circle (23) on Fast Fact Card

is to keep the remote and base in step.

If two or more remotes are used in the system, the RC circuit approach is completely unreliable because either remote is capable of toggling the remote adapter, putting the other remote out of step.

There is no discrete connection to a circuit in the M100 that will put the radio on a given channel. But there is a point in the circuitry where information can be extracted to indicate which channel the radio is on. This point can be accessed via the FPE line, which drives the front-panel F1-F2 indicators.

The FPE line and a CD4066 integrated circuit (IC) quad bilateral switch are used to produce a steering circuit for pulses coming from the remote adapter. Simply put, the steering circuit inhibits channel-change pulses from reaching the F-TOGGLE line when the radio already is on the requested channel.

The CD4066 IC is best thought of as a "relay in a chip." Logic levels pass through the switches, but only when the control input is high.

Referring to Figure 1, Q1 is a buffer that raises the LED drive level on FPE to a level usable by the CMOS IC. Q1 output drives switch A directly and switch B indirectly through switch C, which performs an inverter function. Switches A and B therefore always are in opposite states, and they switch states along with the front-panel F1-F2 indicators.

For example, if the radio is in F1, the control pin (5) is low, opening the F1 switch. Any F1 commands from an out-of-sync remote do not pass to the F-TOGGLE line, so the radio stays on F1. The first F2 command received, though, passes through switch A and toggles the MODE switch.

Subsequent F2 commands have no effect on the radio. In tests with two-tone remotes and an aftermarket tone decoder, it was impossible to disrupt the channel integrity either by manually togging the base or by separately changing the channel of one of the remotes. Channel integrity is sustained because the radio recognizes the channel change command fast enough to change channels before the remote adapter processes the PTT command.

An M100 outfitted with a tone remote adapter, steering circuit and a two-channel scanner makes a low-cost remote scanning base package.

Building the steering circuit is fairly simple. It requires only two radio modifications. Here is how to build one. The IC, transistor and RC combinations mount easily inside the remote adapter, which supplies power to them. Two lines already wired to the mic jack are not used in current versions, PB1 and PB2. PB1 and PB2 run from the front-panel mic jack to the radio logic board via P8. These lines are jumpered easily to the EPA(MODE) and FPE(F1-F2 Indicate) pins of J9, connecting the desired functions to external controls.

Through careful use and reuse of wiring, all remote functions can be accessed through the mic jack, which makes for a neat and serviceable installation. Normal mic functions remain unchanged, so the radio still may be used as a local base if a remote adapter fails.

Useful combination

Once the frequency steering circuit and remote control adapter are installed, the combination becomes useful in a variety of applications, providing a low-cost option to stations costing thousands of dollars more.

An M100 outfitted with a tone remote adapter, steering circuit and a two-channel scanner makes a low-cost remote scanning base package. Because of the LED display operation, this configuration does not work with M216-M218 models in the scan mode.

In addition to providing access to a market that cannot be served with unmodified Radius equipment, an M100 outfitted with a remote adapter is an ideal spare radio. Programmable at a moment's notice, it can be used as a temporary replacement for a front-line base or as a command center during a communications disaster.

Whatever the use, the frequency-select steering circuit is a low-cost modification that greatly increases the M100's capabilities.

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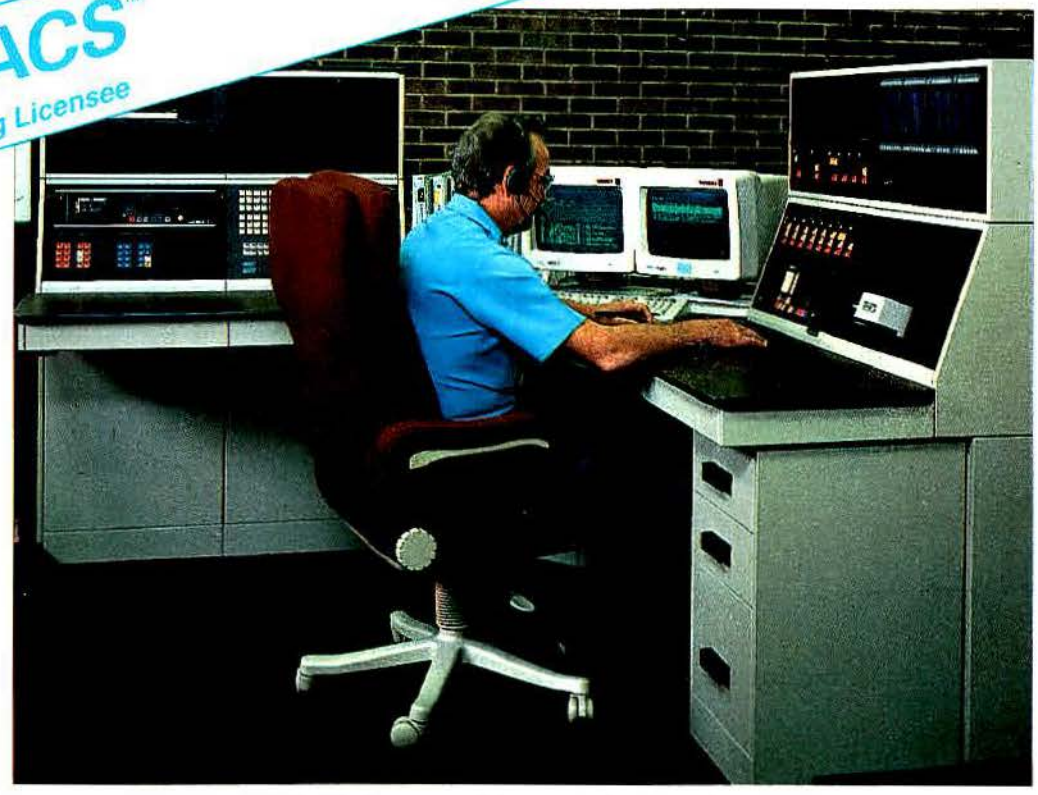

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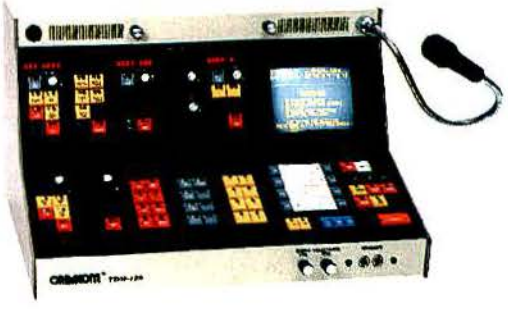

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Circle (25) on Fast Fact Card

Choosing the right caps to bypass RF interference

Lead inductance affects a capacitor's ability to bypass RF to ground to control adverse effects two-way radio equipment operation may have on vehicle electrical devices. The common 0.01μF capacitor is not always the best choice.

By Larry Spalding

Service technicians often are faced with fixing the undesirable effects two-way radio operation may have on vehicle performance.

Sometimes operating a two-way radio causes the vehicle engine to die or causes window wipers to activate unexpectedly.

A rear window wiper on a 1992 Ford Explorer that activated when a two-way radio in the vehicle was keyed led to a re-examination of the typical cure for such problems: bypassing electrical system wires to ground with a 0.01μF capacitor.

A capacitor does not pass the vehicle's 12Vdc current, but it passes radio frequency (RF) energy. The idea is that the capacitor bypasses any stray RF to ground before it can reach the vehicle accessory and cause it to malfunction.

In this case, bypassing the wiper's electrical lead with a 0.01μF capacitor did not stop the wiper delay circuit from falsing when the transmitter was keyed.

Calculations showed the reason to be the inductive reactance of the capacitor's leads.

The straight-wire inductance for a typical 0.01μF capacitor's 22-gauge lead wire 0.4 inches long is about 8.4nH. For two leads, the equivalent series inductance is 16.8nH.

The series resonant frequency for a 0.01μF capacitor and a 16.8nH inductor is 12.28MHz. Above this frequency, the lead inductance has more of an effect on RF than the capacitance. At 150MHz, 16.8nH of inductance has a reactance of about 15.7Ω. At 450MHz, the inductive reactance is about 47.5Ω. These reactance values are far from an RF short circuit that would prevent RF from reaching the wiper delay control.

In the case of the Explorer, capacitor leads 0.2 inches long are required to solder the capacitor from the delay circuit's input lead to the motor case. Given a combined lead inductance of 7.0nH for two 0.2-inch leads, 150pF of capacitance is needed to form a series resonant (short) circuit at 150MHz to bypass RF to ground.

A 150pF capacitor was installed, and the problem was fixed.

The table above shows approximate capacitor values to use for RF bypassing. These values are based on capacitors with 25.3 mil (22 gauge) wire. They result in a series resonant circuit near the frequencies listed.

For other wire lengths and diameters, use this formula to calculate the straight-wire inductance:

$$L = (0.002)(l)[2.3\log(4l/d) - 0.75)]$$

where

L = inductance in μH

l = wire length in cm

d = wire diameter in cm

As shown in the table, lead lengths drastically affect capacitance value at the same frequency.

Sometimes the required positioning of the capacitor does not allow the leads to be cut short. By determining the inductance of the lead lengths that must be used, a capacitor can be chosen that cancels the inductance and bypass RF to ground effectively.

BYPASS CAPACITOR VALUES

SINGLE LEAD LENGTH	TWO-LEAD INDUCTANCE	SERIES RESONANT CAPACITOR VALUE		
		50MHz	155MHz	450MHz
0.1	2.8nH	.0039μF	376pF	44pF
0.2	7.0nH	.0014μF	150pF	18pF
0.3	11.6nH	870pF	97pF	11pF
0.4	16.8nH	600pF	62pF	7pF

Spalding is an area supervisor for the Colorado Division of Telecommunications, Craig, CO.

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MOTOROLA

Circle (26) on Fast Fact Card

Reflected power measurements: Definitions and history

Once you know the background, it makes sense why there are three ways to measure and define reflected power measurements. VSWR, return loss and rho measurements can be converted from one to the other.

By J.S. Beck

Three common terms describe reflected waves in transmission systems: voltage standing wave ratio (VSWR), return loss and rho.

Each term expresses the amount of energy reflected and returned from a load or antenna to the source in a transmission system.

Every transmission system has the following three elements:

1. a generator (transmitter).
2. a transmission line (and not necessarily a perfect one).
3. a load (usually an antenna, but an open and a short are loads, too).

In the ideal transmission system, all energy emits from the generator and passes unattenuated through the transmission line to be radiated or absorbed by the load.

Actual systems have losses, though. For example, transmission lines may not exhibit their rated impedance; they radiate some of the energy they pass; and their dielectric absorbs some energy.

Loads—especially antennas—may present an incorrect impedance. Often, they are tuned to the wrong frequency.

TABLE OF REFLECTION CONVERSIONS

RETURN LOSS	VSWR	RHO	MISMATCH LOSS
0.0dB	∞	1.00	∞
1.0dB	17.40:1	0.89	6.87
2.0dB	8.72:1	0.79	4.33
3.0dB	5.85:1	0.71	3.02
5.0dB	3.57:1	0.56	1.65
6.0dB	3.01:1	0.50	1.25
10.0dB	1.93:1	0.32	0.46
15.0dB	1.43:1	0.18	0.14
20.0dB	1.22:1	0.10	0.04
25.0dB	1.12:1	0.06	0.014
30.0dB	1.06:1	0.03	0.004
40.0dB	1.02:1	0.001	0.00

Three methods

History reveals why three methods were developed for making the same measurement.

➤ *VSWR*—Early transmission lines were 600Ω balanced open-wire feeders. Radio communication took place at frequencies below 1.5MHz.

At these wavelengths (200 mete and up), standing wave measureme could be made with a light bulb. ' the transmitter on, a radio op could move a lamp along the transmission line and observe a changing brilliance if the line had reflected waves.

With the line open or shorted, the lamp would extinguish completely at some points and become brightest at others. Similar experiments conducted with an ac voltmeter instead of a bulb quantified the measurements. Based on the measurements, this formula was derived:

$$\text{Voltage difference} = E_{max}/E_{min}$$

Because these measurements correlated to the standing waves on the line as theorized by James Clerk Maxwell, this ratio was defined as the voltage standing wave ratio.

The term VSWR is used commonly because it makes sense, and it precisely

Beck owns Eagle Wichita, Wichita, KS. The company manufactures return loss bridges.

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defines the phenomenon. Therefore, VSWR is defined as E_{max}/E_{min}.

Modern VSWR equipment does not measure VSWR by tapping into parts of the transmission line. The VSWR meter, calibrated in SWR, uses a directional coupler.

The meter usually contains circuitry that extracts the reflected wave's voltage and current. If there is no reflected wave, the current and voltage are exactly out of phase, and the resultant voltage is 0. When this voltage is compared with the incident (forward) voltage, a ratio, the VSWR, is established.

The term SWR is not exactly synonymous with VSWR, but for practical purposes they are interchangeable. An SWR indication measures the percentage of power loss. Most bridges that are calibrated in SWR have a voltage ratio on top of the scale and a power percentage on the bottom.

With a full scale forward power reading, a half-scale reflected power reading indicates a 3:1 VSWR. The power lost is 25%, as shown by the equation $P = E^2R$. (With a half-scale reading, $E = 0.5$. The calculation is $E^2 = 0.5 \times 0.5 = 0.25 = 25\%$.

➤ *Return loss*—The telephone company developed the return loss concept of reflected measurements. The purpose is to measure subscriber lines at audio frequencies.

For the greatest accuracy, calibration points have to be established by using precision mismatches.

A bridge circuit with an audio voltmeter connected across two arms of a bridge measures the reflected power in the transmission system.

Because the voltmeter reads directly in decibels, return loss specifications were developed in decibels as a power ratio instead of VSWR.

To this day, return loss measurements usually are specified in decibels. Return loss in decibels yields the difference in power level, which generally is a more useful quantity.

For example, if the return loss is 10dB and the forward power is 1,000W, then 100W is reflected. (10dB is a power ratio of 10:1.)

Some return loss bridges have internal diode detectors that are not handy for field use because the output has to be converted to decibels.

For the greatest accuracy, calibration points have to be established by using precision mismatches. If harmonics or other signals are present, they corrupt the measurement beyond correction.

It actually is less expensive to build a bridge with an internal detector because the design eliminates the need for a precise wideband transformer.

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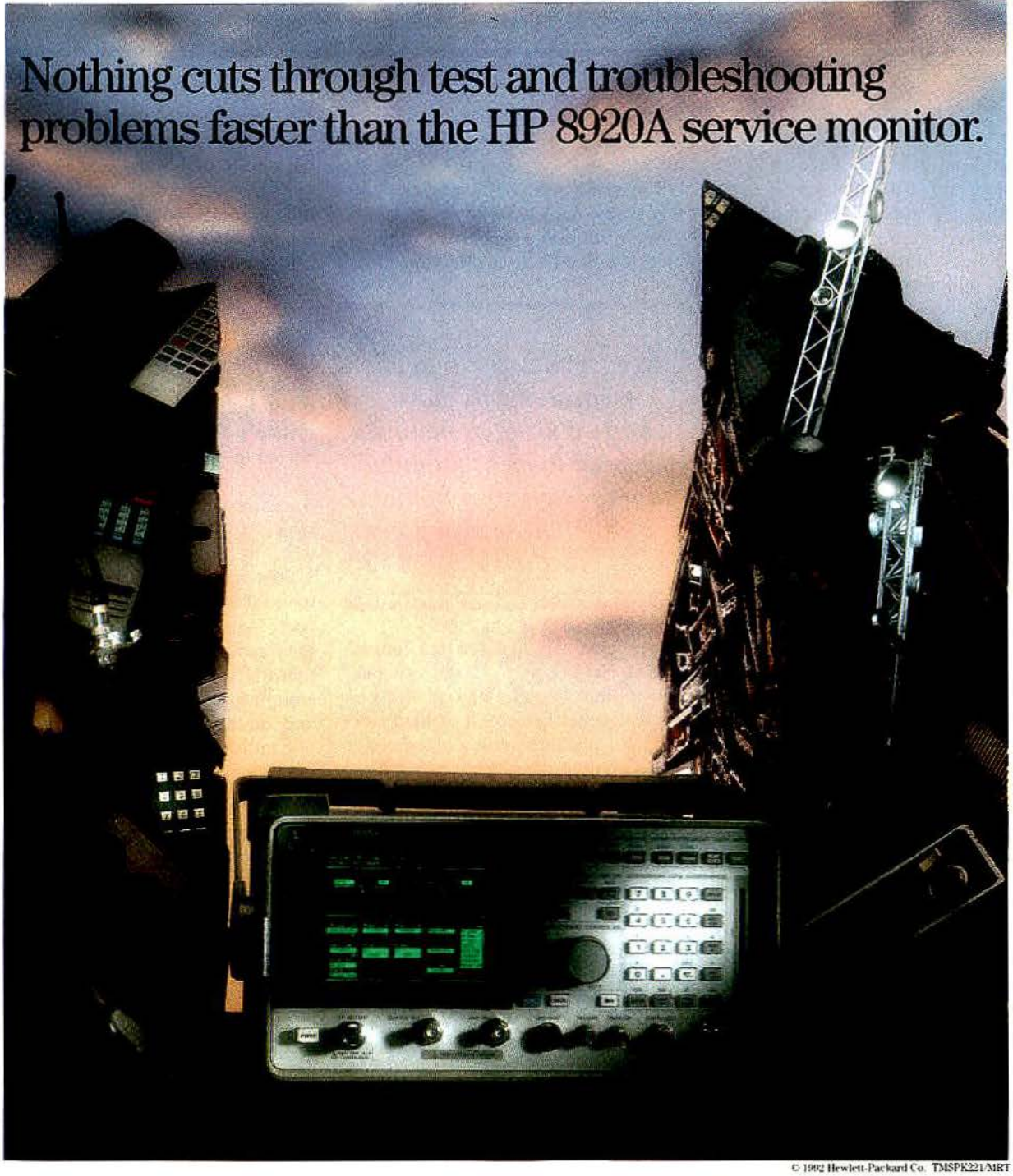

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Circle (30) on Fast Fact Card

The best bridges have an RF reflected port. This port can be connected to a diode detector when necessary.

A better solution is to connect a power meter that reads directly in decibels.

The best solution is to use a spectrum analyzer that measures not only power but the signal frequency. If another signal is close to the measurement frequency, it may be observed on the analyzer, but it will not affect the desired signal's level.

➤ *Rho*—Also known as reflection coefficient, rho is a coefficient related to the magnitude of the ratio of forward and reflected voltages.

Reflected voltage is a percentage of open circuit voltage. The reference for a 100% (infinite) reflection is 1.0 rho.

With early return loss bridges, the reflected voltage port usually was connected to an ac vacuum tube voltmeter (VTVM) such as the HP410B. To improve accuracy, a precision terminating resistor also was connected to load the bridge properly.

The reflection coefficient measurement was made as follows:

With the bridge open or shorted to give a full reflection, the generator's power level was adjusted to a convenient level, such as 1V if the generator power output was limited. A 10V output was better because it yielded more accurate readings at lower reflection coefficients.

New names for reflection measurements have been coined, sometimes when equipment manufacturers want to introduce a different measurement method . . .

The bridge then was connected to the device under test (DUT), and the voltage was noted. If, for example, the initial voltage with the bridge open or shorted is 1V and the voltage with the bridge connected to the DUT is 0.5V, the measurement represents a reflection coefficient of 0.5.

The availability of low-cost spectrum analyzers makes the VTVM method obsolete. Today's measurement technique specifies that the bridge's RF reflected port be connected to the spectrum analyzer input. Then the return loss measurement is read directly in decibels of return loss, which easily is converted into VSWR when necessary.

New names for reflection measurements have been coined, sometimes when equipment manufacturers want to introduce a different measurement method and to promote particular equipment models. These new names and methods invariably represent a variation of one of the three common definitions of VSWR, return loss and reflection coefficient.

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30 minutes:	125 watts	250 watts	600 watts
Surge:	200 watts	500 watts	1500 watts
Continuous:	100 watts	200 watts	500 watts
Input Voltage:	10 to 15 VDC	10 15 VDC	10 to 15 VDC
Output voltage:	115 VAC RMS ± 5%	115 VAC RMS ± 5%	115 VAC RMS ± 5%
Output frequency:	60 Hz ± 2%	60 Hz ± 0.01%	60 Hz ± 0.01%
Output waveform:	modified sinewave, phase corrected	modified sinewave, phase corrected	modified sinewave, phase corrected
Efficiency:	90%	90%	90%
Low battery alarm:	10.7 V	10.7 V	10.7 V
Low battery shutdown:	10 V	10 V	10 V
Dimensions (H x W x L):	1.2" x 3.5" x 4.5"	1.5" x 4.5" x 6"	3" x 9" x 10"
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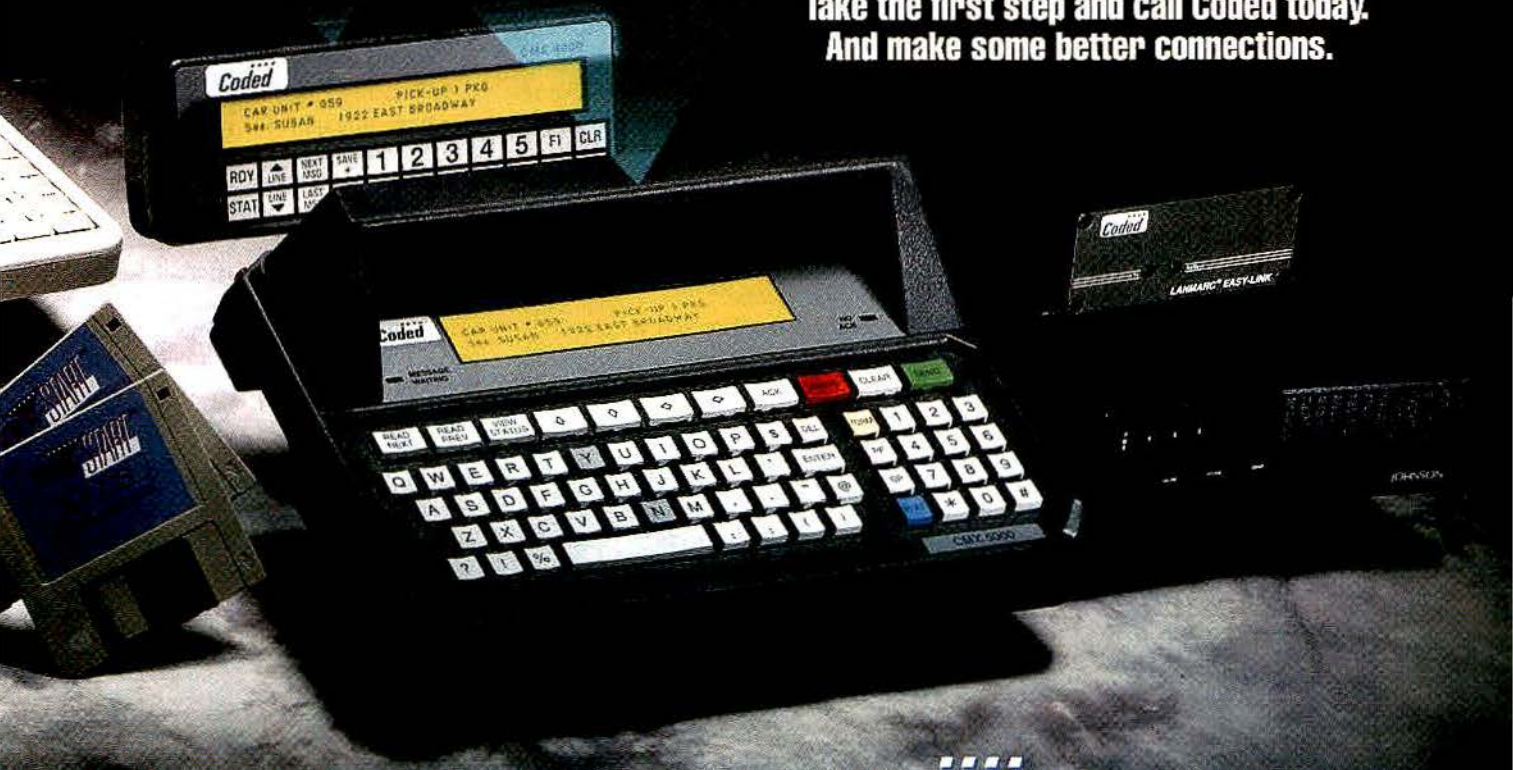

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Circle (33) on Fast Fact Card

When bad radios happen to good people

Your radio service shop may benefit from giving customers lists of service tips. Helping customers prevent radio failure and fix simple problems themselves boosts their satisfaction and loyalty to your business.

By Mike Mekelburg

I once fixed a frustrating intermittent problem with a customer's portable radio at the service counter as he was checking it in.

The fault was a common failure with that model of radio, one that the office administrative staff often would diagnose and repair before starting any paperwork.

This particular customer did not know whether he was mad or glad that the repair was so simple. "Why don't you send out flyers to inform us about this kind of thing," he said. "I don't have time to bring my radios in because they have a couple of loose screws."

Our company took his advice. At first, we were concerned that a list of common radio problems that customers could watch out for, however universal they may be, might give some customers the impression that they were buying cheap radios. To the contrary, the feedback has been quite positive, and our reputation of sincere concern for customer satisfaction has been enhanced.

Mekelburg is lead technician at Confidential Communications Services, Flagstaff, AZ.

Our tips for customers are organized on two separate one-page flyers, available in the office reception area and sent by mail upon request. Printed on company letterhead, the lists are suitable for posting at the customer's place of business.

An introductory sentence tells the customer the list is intended to save repair shop dollars and costly downtime.

First flyer

Here is an example of information included in the first flyer:

Portable radios:

1. Radio baseplate screws can loosen because of handling and vibration, causing intermittent battery contact and operation. Tighten the screws gently every few months with a small screwdriver.

2. If any control knobs loosen, bring the radio in for service immediately because the plastic flexible circuit inside may tear.

3. If you suspect a radio has a problem, swap antennas, batteries and chargers with a similar unit to help to isolate the problem.

4. Avoid handling any radio by its antenna. The insides can break even though the exterior looks fine.

5. Leather cases and plastic holders can prevent expensive impact damage.

6. Keep radios turned off when they are in their chargers.

7. Know your radio alert tones. A "chirp-chirp" indicates a low battery. Different brands use different tones.

A battery generally will last about a year-and-a-half with normal use. If a battery will not hold a charge for more than eight hours, bring it in for a run

Mobile antenna contacts can be cleaned with an ordinary ignition file.

The battery and charger contacts can be cleaned with a pencil eraser.

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For more information about Uniden Pagers, Call 1-800-292-2294.

Circle (34) on Fast Fact Card

Show the customer the proper method for securing battery plate screws.

through the analyzer-conditioner.

Mobile radios:

1. Ensure all cable connectors are secure. The roof-mount antenna connector center contact can be polished with an ordinary ignition file every few months (after a car wash).

2. Microphone, antennas and even radio boxes can be substituted with similar units to help to isolate a problem.

Second flyer

The second flyer covers do's and don'ts of portable battery care, a topic customers often ask about. Battery capacity, charging cycles and memory effect are explained in the introduction.

...lists can be customized for any shop's particular needs. Your efforts toward customer satisfaction will be noticed.

Here is an example of information included in the second flyer:

1. Minimize memory effect with a twice-monthly deep discharge (leave the radio on all weekend) followed by a full recharge.

2. Use only the charger designed for the battery to be charged.

3. Keep all charger and battery contacts clean. A pencil eraser works great.

4. Allow the battery to reach room temperature (normally about one hour) before placing it in the charger.

5. Store NiCd batteries fully charged in a cool, dry place.

6. Do not discard a battery until it has been checked for memory effect.

7. Do not store or transport batteries with loose metal, such as coins, paper clips and keys, to prevent short-circuiting.

8. Do not use NiCd batteries as a hammer, and do not dispose of them in a fire.

These example lists can be customized for any shop's particular needs. Your efforts toward customer satisfaction *will* be noticed.

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Circle (36) on Fast Fact Card

...Follow the Leader

Public safety enters the '90s with projects, goals

Electronic data interchange (EDI), digital standards and Project 25, and an overview of new projects top public safety's communications interests. Here are highlights from the Seattle conference, Aug. 10-14.

By Jane Bryant
Staff Editor

Project 25 and the advent of digital radio, as well as other projects, garnered much attention during the Associated Public-Safety Communications (APCO) national conference Aug. 10-14 in Seattle. APCO, South Daytona, FL, is a trade organization dedicated to the enhancement of public safety communications. Here are the highlights:

➤ *Project 25*—The APCO Project 25 Committee met during the conference to iron out details to bring digital radio into reality for the public safety sector. "Our goal is to have a standard that will allow us to meet with signals in the air," according to APCO president John Powell. Project 25 is a joint effort of APCO and the National Association of State Telecommunications Directors (NASTD).

There is full participation with Canada and the Canadian regulatory body, he said. "We are moving toward an international standard," Powell explained.

Project 25 began in Albuquerque, NM, in 1990 to set digital standards for public safety communications. The committee has been evaluating technology for the standard selection over the past two years.

APCO-NASTD project 25 committee representatives

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Bendix/King
Cycomm
Digital Voice
E. F. Johnson
Ericsson GE
GEC/Marconi
Glenayre
Motorola
SEA

FDMA

Frequency division multiple access (FDMA) was determined as the access method, and it was reaffirmed at a recent Project 25 meeting, despite the demonstration of time division multiple access (TDMA) by Ericsson GE Mobile Communications, Lynchburg, VA, at the show. FDMA allows split channels to 12.5kHz and is favored by Motorola, Schaumburg, IL.

TDMA

Ericsson GE's TDMA EDACS digital trunking technology offers advanced features and spectrum efficiency. EDACS enables implementation into existing systems and has provisions for future generations of equipment. Ericsson GE said it will work with the Project 25 Committee and will support the standards process.

Besides the access method, other Project 25 standards have been determined, with the exception of the trunking access, which still is pending.

Modulation scheme

QPSK-C is the modulation scheme adopted. "It allows a migration path to what we use today and what we will use in the future at 6.25kHz," according to Steven Proctor, APCO first vice president.

Vocoder tests were reviewed during the meeting, and improved multiband excitation (IMBE) was selected as the standard. Digital Voice Systems Inc. (DVSI), Cambridge, MA, makes the vocoder, which takes analog voice and makes it digital.

"Digital is as important to radio systems as when we went from CW (Morse code) to voice," Powell said. "We don't want what happened in trunking—various standards—to happen to digital."

The Project 25 Committee had a meeting scheduled at press time to discuss the digital standards further.

➤ *Project 26*—Project 26 is an endeavor to find a solution to frequency congestion in the New York-New Jersey area. It started in 1990 and is headed by Vincent R. Stile, communications system director for Suffolk County Police Department in New York.

The committee filed a waiver request for frequencies from HDTV—ATV—and is waiting to hear from the FCC. "HDTV is going to be a battle, so right now, we are working on a political fight," Stile said. "UHF-TV Channel 16 is the frequency we are after."

Stile said the Los Angeles County Sheriff Department went through the same thing and eventually secured frequencies. "We have fire agencies that can't talk to police. It's an

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interoperability issue," he said of sharing UHF-TV spectrum.

The FCC released its proposed HDTV channel assignments in the UHF band, and these are out for comment to broadcasters, who will rearrange the list and submit it to the FCC, Powell said.

A list then will be published. When the list is published, public safety agencies will see the list and should submit their comments on this, Powell stressed.

Initial HDTV sets are selling for as much as $5,000 each, and if the price does not drop substantially after 20 years, the channels could go back to public safety, Powell said.

➤ *Project 28*—Project 28's goal is to protect 2GHz microwave frequency from personal communications service (PCS) and personal communications networks (PCNs). "We support PCS, but don't take our frequency away again," Powell said.

Sen. Ernest Hollings, D-SC, proposed legislation to permanently exempt public safety from reallocation, and the legislation is in the House for review. "Next to National Defense, public safety gets spectrum," Powell said.

Project 28 has had major successes, he said. "We can tolerate zero interference to our systems," Powell said.

➤ *New projects*—Two new projects have been slated by APCO— Project 31 and Project 32. Project 31's purpose is to identify PCN's and PCS' role in the future of public safety communications.

According to the Cellular Telecommunications Industry Association, Washington, DC, the cellular industry has 9 million customers now with 222,000 users coming on-line a month, so APCO is examining its role in PCS. "We have very little direction or scope where PCS is heading," Powell said. "We want to look at it."

Under the Project 32 heading, APCO plans to generate information technology membership criteria for information technologists who support public safety communications. The association acknowledges a need for an information technology sector based on the influx of exhibitors involved in this area at its annual meeting and show. System integrators such as Fairfax, VA-based TRW Command Support Division and International Business Machines'(IBM) Public Safety Solutions group exhibited at the show. (See *News*, October 1992.)

➤ *Electronic data interchange*—Electronic data interchange (EDI) for FCC filings is under review by APCO, and APCO is the only association transmitting electronically in full today, according to speaker Steve Slavin of Chevron Information Technology. SIRSA is doing a little by EDI, and NABER has declined, he said.

ANSI accreditation of the draft standard for the FCC began in June, and

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pilot transmittals began in July. There are about 150 vendors that handle EDI software, and Supply Tech, Ann Arbor, MI, was selected as the vendor for the pilot test only, which means that other vendors are not locked out of submitting bids for the actual system, Slavin said. The pilot tests are expected to be completed this fall.

An EDI filing system would alleviate many of the delays inherent in today's licensing structure. For instance, last year 15,700 applications were mailed back from the FCC for corrections. With EDI, data can be sent back and forth from the commission for simple questions to be answered electronically to save delays.

Concerns

Before EDI can become reality, these items need to be addressed:

- The original signature requirement needs to be eliminated. Senate Bill 1132 to eliminate the signature requirement has to become law before EDI can happen.
- The payment of fees needs to be addressed, but in most cases, APCO is exempt of fees, so this issue should not pose a problem for APCO.

Last year 15,700 applications were mailed back from the FCC for corrections. With EDI, data can be sent back and forth from the commission for simple questions to be answered electronically to save delays.

- Attachments and system description segments can be amended to convert graphics into text paragraphs.

The EDI benefits to the coordinators are improved service and turnaround to members; and FCC audit of services and fees, which will keep costs down.

Costs

The costs of EDI may appear high to some users, but not everyone will use EDI. The goal is to get the costs down, and those companies already involved with EDI will have lower costs.

"EDI costs $300 to the sky-is-the-limit, depending on what you want to do," Slavin said. Based on a modem and personal computer already in place, a ballpark figure is $2,000 plus labor to develop a data base for an FCC application and one or more overlays, Slavin said. This is an average one-time cost to start. Maintenance costs may run $100 to $500 a year, he said.

➤ *APCO goals*—APCO president John Powell set the following goals for the organization under his reign:

- To top the 10,000 mark in mem-

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bership. The organization has more that 9,500 members currently.

- To participate more at sister organizations.
- To incorporate electronic data interchange (EDI)—ANSI transfer with the FCC filings. "Terry Fischel of the FCC said when the EDI system is up, the commission could award licenses in as few as three days," according to Powell.
- To look at 9-1-1 standards for an interface between wired and public safety communications.

POWELL

➤ *APCO officers*—New officers were selected for the 1992-93 year with Ronnie Rand, outgoing 1991-92 president, selected as the organization's new executive director. (See *News*, October 1992.)

APCO selected Powell as president for the next year. Other new officers include president-elect Frank L. Huggins; first vice president Proctor; and second vice president Ross Morris.

"We need new blood, new ideas and different people willing to get involved."
— John Powell

The APCO board of officers is the policy-determining body for the association and its subsidiaries. The members of the board are elected from the active members of the association.

At a future leaders seminar, Powell reached out to members to become active in the organization. "We need new blood, new ideas and different people willing to get involved," he said.

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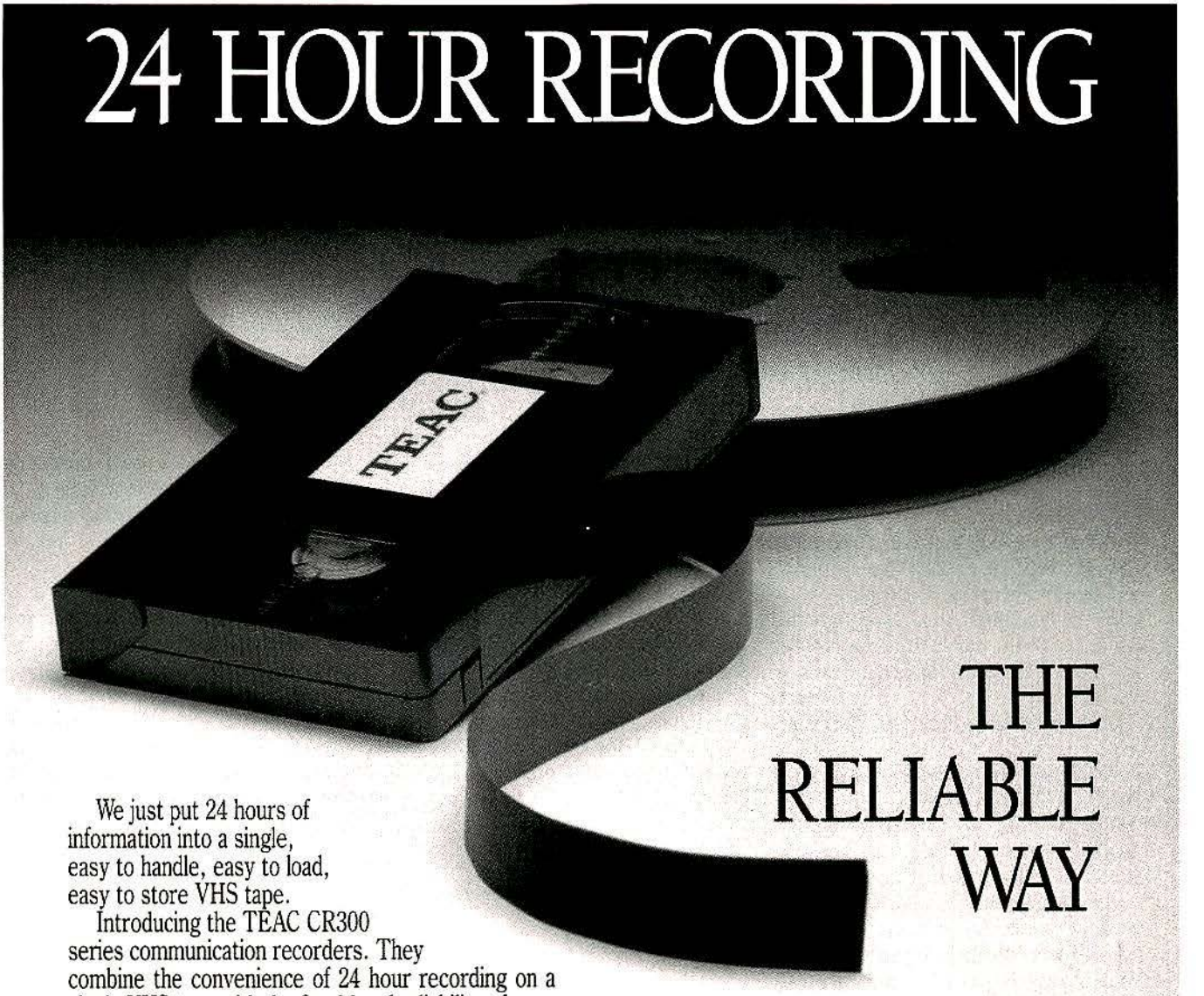

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Zen and the art of systems maintenance

The real system you're working on is yours.

By John Lapham Sr.

When Gregory Bateson first introduced General Systems Theory undergraduate courses at Stanford University, he lamented that, although the students could name the components of a system, they "lacked epistemic cognition."

In other words, they just didn't get it.

What bothered Bateson was the students' inabilities to apply terms they had used to real systems in a way that demonstrated that they truly understood systems thinking.

Troubleshooting a multisite paging system gives me many opportunities to discover whether or not "I get it." Whenever I visit a site to check a problem, I realize the problem may have origins elsewhere in the system.

The Olympia visit

One day began with a trip to Olympia, WA, 70 miles south of Seattle. Stopping at a coffee shop a block from the transmitter shelter, I eased from behind the steering wheel and immediately stooped over. Something had gone out in my lower back, and I could not stand upright. I thought over the morning and could not recall having lifted anything heavy.

After filling my thermos with fresh coffee, I went on to the transmitter shelter where I began the diagnostics on the QT-250B transmitter.

The grid current was quite healthy at 10mA, but the plate current was 170 mA. For 100W output, that was too high. The tube was beginning to show signs of age. But was that causing the missing pages? Not likely.

Next, I listened to the link receiver signal. It was strong, very strong. The 2,175Hz keying tone could be heard at the beginning of each transmission, and the receiver and transmitter modem key light came on properly.

I listened for the brief 660Hz FSK mode signal, which comes on after the initial 2,175Hz signal. It too was evident, as was the modem's FSK status light.

Whenever I visit a site to check a problem, I realize the problem may have origins elsewhere in the system.

The key and mode signals are part of the signaling subsystem for the paging system.

Systems are made of interdependent, interrelated components. Some components make subsystems.

Paging terminal signals include transmitter signaling tones, as well as CAP codes and digital, audio or alphanumeric data. *The 2,175Hz and 660Hz signaling tones form a subsystem.* Because they were present, the missing pages were caused by other reasons.

Next, I observed the transmitter output on the service monitor. The digital FSK signaling looked good. Deviation was correct, and the square waves were picture-perfect. *The modulation subsystem* was operating correctly.

It was time for some test pages.

Bad news. The Olympia site was sending corrupted pages. It wasn't exactly "missing pages," rather, it was transmitting corrupted data for some of the pages. In this case, four of the 10 pages were useless. Some only had three or four digits. Now what?

Remember, in paging systems, phone calls come from the local area serving the paging terminal and from long-distance lines. Even if these long-distance lines are dedicated as non-toll lines, they extend over a much greater distance. *The long-distance lines represent a subsystem* of the paging terminal telephone line system.

With that thought in mind, I called a technician at the shop in Seattle and asked him to send 10 test pages. Bingo! All 10 of pages came through uncorrupted.

I considered that the problem might be a bad trunk card at the paging terminal, but if that were the case, there would be missing pages on locally dialed calls, also. Because no trunk cards at the paging terminal were dedicated to long-distance lines, the problem probably had to do with low signal levels coming into the paging terminal.

I called another technician and told him the problem was with the long-distance telephone lines. He agreed with my reasoning and was satisfied that the paging transmitter was working properly.

The Lake Stevens visit

Before I had time to congratulate myself, my other pager started beeping. I looked at the liquid crystal dis-

Lapham is communications systems field engineer at Ratelco Communications, Seattle. Ratelco is a division of Clackamas Communications.

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OGB6-900 (K-7516641)	6 dBd	890-960 MHz	V	Radome-protected Collinear Dipole Array
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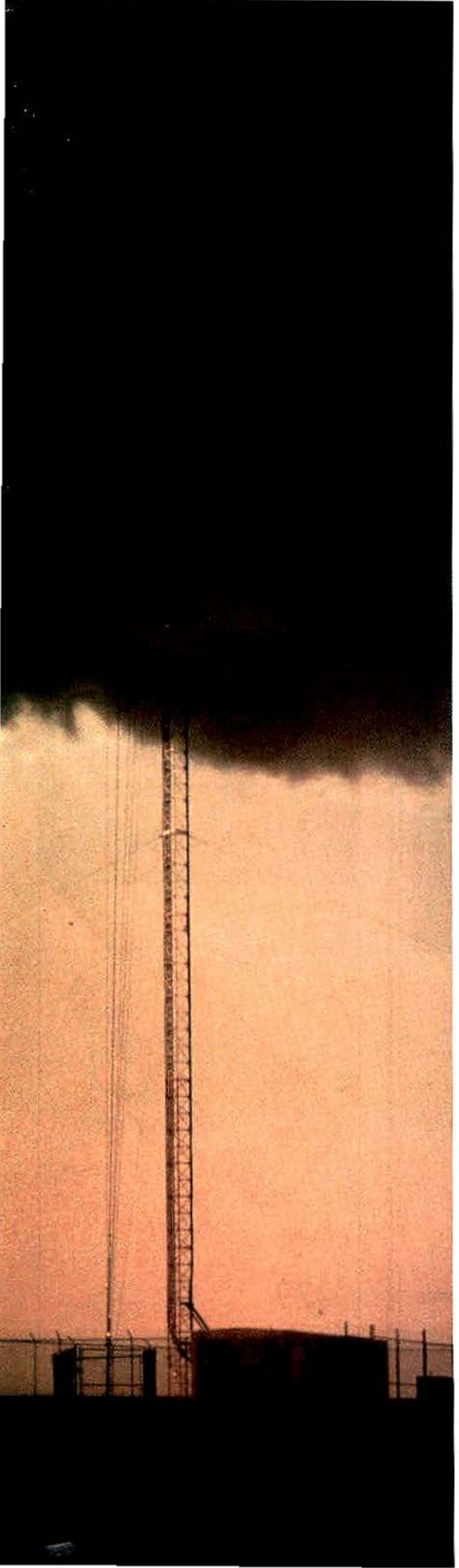

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play (LCD) and saw a familiar number. This time the problem was with the Lakes Stevens paging site 100 miles away. The monitoring equipment was sending "low power" alarms.

"Darn," I muttered. "I've fixed that three times this week and it still doesn't work."

Loading the equipment into the Toyota, I realized that my back still was in bad shape. But that had to wait.

My house is a few blocks from an I-5 on-ramp, so I stopped by to let my wife know that it would be another late night for me. She noticed my back bothering me and asked whether I injured it.

"No," I replied, "it just happened out of the blue."

With my thermos filled with coffee, I hit the road for Lake Stevens. When I got there, the transmitter was at full power.

I called the answering service. The service reported that the Lake Stevens status alarm reporter stopped calling in almost exactly when I arrived.

What could it be? For three days the status alarm reporter had been calling in with a low power alarm status. And for three days I had been running up to Lakes Stevens to find absolutely no power output problems.

. . . so now I just sat and stared at the backside of a paging transmitter and waited for the Buddha to whisper in my ear.

Troubleshooting review

I went over my troubleshooting procedures. Each time I entered, opened the cabinet door, took down the readings, monitored the output and kept my eyes on the power output and the status alarm reporter. I had checked the reporter already, and it was operating properly. What could the problem be?

I swung the transmitter away from the wall and opened the cabinet's back door. Taking my screwdriver to every terminal block, I made sure that each screw had been torqued properly. Nothing was loose.

I brought my stool around back, sat down and stared at the equipment. I was at a loss for ideas.

'Stuckness'

In *Zen and the Art of Motorcycle Maintenance*, author Robert Persig refers to this state of mind as "stuckness." My mind was stuck in a rut that was getting me nowhere with this problem, so now I just sat and stared at the backside of a paging transmitter, and waited for the Buddha to whisper in my ear.

I reviewed the week.

I first came to Lake Stevens to install an intermod filter in the transmit-

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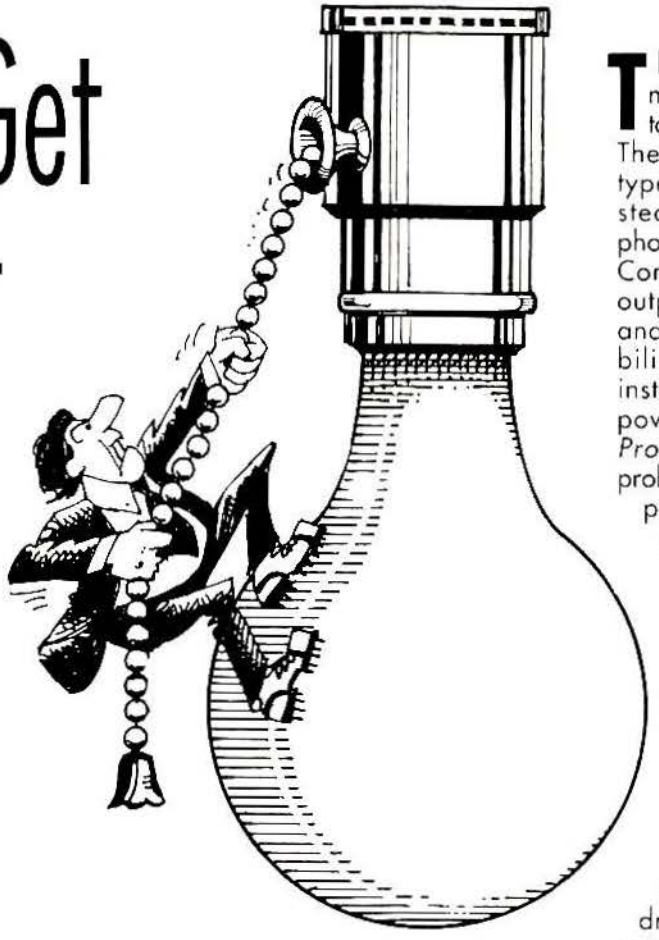

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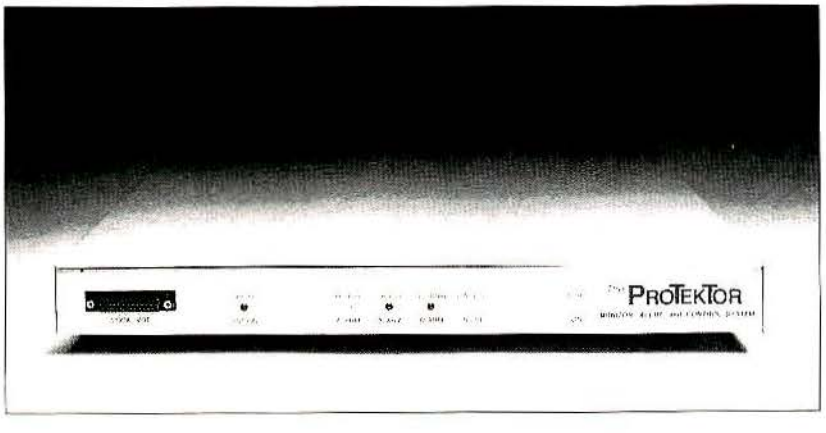

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ter. Because the filter reduced the power output, I adjusted the power to compensate, but the power still was below the transmitter's rated 100W.

Could there be a heat problem? My eyes scanned the back of the transmitter. Eventually they rested on the 3-inch box fan. I counted the blades, all four of them. Wait, why had they stopped turning?

The Buddha had whispered. A flood of revelations surged through my mind. Each time I came to Lake Stevens, I opened the cabinet door, cooling the transmitter.

The cooling system had failed at the back of the transmitter, but when I opened the door, the system had experienced second-order change.

Second-order change occurs in a system when chaos is introduced. In this case, the cooling system works as a closed-cabinet cooling system. Sensors inside the transmitter measure temperature and close a switch when the temperature reaches 90°F.

But this sensing system design is predicated on a closed-cabinet model. With the doors open, it no longer is the same system. I had thrown a little chaos into the cooling system and, in the process, upset the sensing system.

The science of chaos

Chaos by James Gleick introduces readers to this new science.

Gleick's introduction to this new science of *process rather than order* tells of Edward Lorenz, a Massachusetts Institute of Technology (MIT) researcher.

Lorenz once was using a computer to plot weather patterns. As an extremely simple mathematical model generated the weather patterns, Lorenz watched the screen as weather fronts unfolded.

The differential equation contained only a few terms, nothing quite like real weather mathematical models, but the equation was enough to generate warm fronts, cold fronts, thunderstorms and so forth on his make-believe planet.

One day, as he watched a weather front emerge, someone telephoned him and asked him to come to another MIT campus office where he conducted research. He stopped the program and resolved to continue it in its current weather pattern later.

When he returned, he re-entered the numbers he previously used. In a few minutes, he witnessed the creation of an entirely different weather pattern. It did not resemble his original weather pattern in the slightest. Exasperated, he re-entered the numbers, and the same "problem" occurred.

It was some time before he discovered that, when re-entering the numbers, he had entered 0.506 for one value when the exact value was 0.506127. Because he had omitted the numerical value 0.000127 from his re-entry, an entirely different weather system had been created. By this error, the description of a new science came in to being: The science of chaos.

The problem with second-order differential equations found in many scientific and engineering problems is that, when certain values are exceeded, the equation no longer produces predictable outcomes. This was the case with Lorenz's weather pattern-generating equation. More importantly, in making this error he introduced the concept of *sensitive dependent initial conditions*.

That 127/10,000 difference in the entry for one value in the equation was so important that, although nearly infinitesimal, it dominated the outcome of the equation's solution.

Systems are composed of interdependent and interrelated components.

Remember the Olympia site? When paging information is sent to the site, several things happen before the transmitter begins sending. First, the 2,175Hz tone must arrive to key the transmitter. A 660Hz tone must follow soon after to put the transmitter in FSK mode.

If the 660Hz tone is not detected, the transmitter remains in analog mode, and no digital paging data is transmitted. This is an example of sensitive dependent initial conditions.

For the paging transmitter in Olympia, the second-order change is the change from FSK modulation to analog modulation when the initial conditions are violated. At the Lake Stevens site, the second-order change occurred when I opened the cabinet door. The sensitive dependent initial conditions had changed; therefore, the outcome changed significantly.

Back to the back

After installing a new fan, I began loading my equipment into the truck. As I pushed the bucket seat forward, I noticed that it was not in the position where my back felt most comfortable.

Earlier in the day, before leaving for Olympia, I must have put something behind the seat and failed to adjust the back rest properly. That change in how the back rest inclined had affected my lower back support. No wonder my lower back was out. *Sensitive dependent initial conditions had struck again.*

It was 9:45 p.m. when I pulled into the garage.

When I stepped inside the house, I saw my wife, Doris, working on a Word Jumble puzzle in the newspaper. She enjoys unscrambling the letters and solving the puzzle. Looking up, she asked, "How's your back?"

. . . language is a communications system, and words are subsystems. Letters of the alphabet are components in this word subsystem. . .

"Oh, it's fine now. It was just a systems problem," I replied.

She looked confused for a moment and then returned her attention back to her own systems problem.

You see, language is a communications system, and words are subsystems. Letters of the alphabet are components in this word subsystem, and in the case of the Word Jumble puzzle, the components are in the wrong order. Thus, there is a systems failure to communicate. And Doris was trouble-shooting that systems problem.

Systems are everywhere.

Reference material

1. Gleick, James, *Chaos Making a New Science*, Penguin Books.
2. Jessen, Elaine, *Systems Theory I*, Antioch University, Seattle. (Kinko's Copies, 810 NE 45th St., Seattle, WA 98105).
3. Persig, Robert, *Zen and the Art of Motorcycle Maintenance*, Bantam Books.

Tower lighting continues under scrutiny

With the recent FCC bombshell issuance of tower lighting violations to multiple licensees on towers, owners and licensees alike are concerned about the heavy fines levied and the liability for deficient tower maintenance.

The FCC, in conjunction with FAA guidelines, requires tower lights to be checked daily for proper operation, and it makes all radio licensees that use the tower responsible for maintaining aviation obstruction marking and reporting light outages to the FAA promptly. The licensees are subject to a "base amount" $8,000 fine for lighting violations.

"If you are a tenant on a tower, get it in your contract that if there is a forfeiture of money for a violation, make the tower owner responsible for payment," Ralph Haller, Private Radio Bureau chief, told an audience at IMCE/Fall in Atlanta in September.

The FCC is looking at some changes in its tower lighting regulations, Haller said.

In the meantime, companies emerged at IMCE/Fall to assist licensees and owners with tower lighting concerns.

One company, TowerWatch, Topeka, KS, offers a 24-hour-a-day tower monitoring service. The company has two monitoring facilities, one in Cape Girardeau, MO, and the other in Leavenworth, KS.

TowerWatch can install a system to monitor tower lighting continuously, and if a problem develops, the system reports it to the company's central station. The company notifies its clients of outages and, if the customer desires, will notify the FAA. Lighting outages are to be reported to the nearest FAA Flight Service Station office if they are not corrected within 30 minutes.

TowerWatch has 15 major clients, and some of these have multiple licensees and sites.

Gilcris Lighting, Richmond, VA, makes a 20-year light bulb for tower beacons. The Krypton gas bulb enhances brightness and extends filament life, offering 175,000 hours of use.

The Performer light bulb is guaranteed by Gilcris for 20 years and is available in 600W or 85W. The light bulb consumes less power than traditional bulbs.

Gilcris has been manufacturing a long-life battery for consumers and delved into the tower obstruction marking business six months ago.

MSS future in mobile radio indicates growth

Land mobile radio is the fastest-growing segment of mobile satellite service (MSS), according to Ron Mario, president of Comsat, Washing-

ton, DC. Currently, land mobile constitutes only 15% to 18% of the MSS market, Mario told a September IMCE/Fall audience in Atlanta. That figure is expected to increase rapidly as Comsat debuts its land mobile terminal.

Around the first of the year, an Inmarsat-M land mobile terminal is due. The prototype unit weighs about 25 pounds, but Mario anticipates the working model's weight to be 10 pounds. "This will be our next step in communications growth," he said.

Mario foresees revolutionary services in 1993. These include:

- ➤ global paging service.
- ➤ personal hand-held satellite telephone.
- ➤ more integration of satellite and cellular service.
- ➤ evolution of digital capability.
- ➤ some form of PCS service.

Exponential growth in services is expected for MSS, he said. "I think the land mobile side over the next three to four years will dominate growth in satellite services in terms of percentages," he said.

NDC to provide alpha dispatch for SkyTel

SkyTel, Washington, DC, has selected the National Dispatch Center (NDC), San Diego, to provide operator dispatch of paging messages in the United States for its SkyWord alphanumeric paging service.

SkyTel chose NDC after months of examining various options and testing NDC service. The NDC systems will maintain SkyTel's PIN number input and then answer calls with a personal greeting upon the subscriber's request.

National Dispatch Center, Anterior Technology join to provide E-Mail services

The National Dispatch Center (NDC), San Diego, and Anterior Technology, Menlo Park, CA, have agreed to provide electronic mail services for alphanumeric pager and electronic mail users. Anterior Technology will provide an electronic mail (E-Mail) gateway, and NDC will provide the network hub and distribution to paging companies throughout the United States.

Subscribers can now receive notification on their alpha pagers that they have E-Mail waiting. They can also send full-text messages to anyone in the NDC database from their E-Mail systems.

The alphanumeric page shows the date and time the message arrived, its subject matter, sender and urgency, and the subscriber can choose to have the system send pages based on the listed criteria. For example, subscribers can choose to have only E-Mail messages from a specified person or of a specified urgency generate an alphanumeric page.

News

Alexander wins partial judgment

Alexander Batteries, Mason City, IA, has prevailed in U.S. District Court for the Northern District of Iowa on a motion for partial summary judgment. Alexander had filed a motion that two of Motorola's patents, which allegedly cover the Dynatac portable cellular telephone and STX two-way and related two-ways, were not infringed because Alexander did not make cellular telephones and two-way radios. The Court agreed with Alexander that their batteries did not infringe these patents because the use of a replacement battery is permissible repair.

The Court denied Motorola's motion to dismiss Alexander's counterclaims, including an antitrust counterclaim for monopolizing or attempting to monopolize the battery market; an Iowa common law counterclaim regarding interference with Alexander's prospective contractual relationships; and a federal Lanham Act counterclaim, based in part on a Motolola press release, which the Court said was misleading.

Motorola, Schaumburg, IL, began this action in November 1990, alleging patent infringement of a number of U.S. patents. Alexander has counterclaimed against Motorola, alleging various acts of unfair competition.

Signalcrafters acquires Ledex Products

Signalcrafters, Lawrence, KS, has completed the acquisition of the Ledex Communication Systems Products line from Lucas Ledex, Vandalia, OH. Lucas Ledex is a division of the British multinational company, Lucas Industries.

The line-up includes Netcheck communication path testing systems; sub-SCADA alarm, telemetry and control systems; Cell-sentinel remote site monitoring and communications systems; and SpecSYS signalling format conversion systems.

Technician-Of-The-Year program continues

By Thomas Green

The Technician-Of-The-Year awards program recognizes the role technicians play in the industry and honors a technician who shows outstanding effort in customer service, job performance, professionalism and teamwork.

Michael Tillett of Coastal Communications, New Bern, NC, accepted the first award in May 1992 at NABER's Annual Mobile Communications Conference.

The ACT volunteer leadership council believes the award program already has advanced the reputation of technicians and the entire industry and wants to expand the program.

Planning for the 1993 award program has begun. Nomination forms will be available soon.

Take time to nominate someone who has demonstrated the qualities characteristic of an outstanding technician. Your participation is important not only to the program's success but also to successfully increase the general awareness and appreciation of contributions communications technicians make to the industry.

Council seats open

The volunteer leadership council seeks new council members. ACT members may nominate themselves or others who are active in the communications industry.

Candidates must be willing to attend two council meetings per year during a two-year term.

If you are an ACT member and want to become more involved in membership activities, or if you want to request ACT membership information, telephone 800-759-0300 and ask to speak with Danielle Poux.

Certification

Technician certification exams are offered nationwide at Plato centers Monday through Friday.

For an appointment or to obtain more information about the certification program, telephone 800-759-0300 and ask for "technician services."

Green is instructor and communications manager of communications electronics at Ranken Technical College, St. Louis. He is ACT's volunteer leadership council chairman. ACT, the Association of Communications Technicians, is a membership section of NABER, the National Association of Business and Educational Radio.

Information

For more information about ACT and technician certification information and exam appointments, call 800-759-0300. Ask for 'technician services.'

FCC modifies decision for short-spaced SMRs

On Aug. 17, the FCC affirmed its decision to permit specialized mobile radio (SMR) stations to locate their facilities closer to one another than the nominal minimum co-channel mileage separation, a procedure known as short-spacing.

In the same action, the commission extended from 10 days to 30 days the time allowed for a licensee to evaluate waiver requests and to oppose them if desired.

The agency adopted a directional method for calculating antenna height above average terrain (HAAT) when an applicant uses the short-spacing table and expanded the short-spacing table to include columns for 500W and 300W.

The FCC turned down a request to modify the existing co-channel interference criteria used to evaluate waiver requests, retaining as elements in such an evaluation the 40dBu contour of the existing station and the 30dBu contour of the proposed station.

Another request that the agency denied was to require short-spacing applicants to use an existing station's maximum permissible power and antenna height rather than the station's actual operating characteristics when using the FCC's short-spacing table. The commission stated that all stations, once licensed, are afforded the same protection.

Federal Communications Commission faces $7 million deficit

The FCC may contend with as much as a $20 million deficit for the next fiscal year, according to Ralph Haller, Private Radio Bureau chief at IMCE/Fall in Atlanta in September. Haller said that because of budgeting, the deficit will be at least $7 million.

The FCC chairman put a note out to the staff that the commission may have to shut down to save money. "We're really to the point that we are counting copy paper," Haller said of the budget. "Look for strange things to come out of the FCC."

Haller expects seven to 14 furlough days where the commission could be closed in light of its budget. If this happens, licenses could be delayed.

MobileComm requests license for message delivery system

MobileComm, Ridgeland, MS, has applied to the FCC for an experimental license to develop a message delivery system. Acording to engineering vice president Bill Stacey, the new service will send detailed data to a portable receiver that transmits verification of receipt to the sender.

SMRs as personal communications service operators?

The commission anticipates personal communications service (PCS) will advance quickly, offering a variety of services to communications users. "We hope PCS will evolve a lot faster than cellular, and we want to avoid the pitfalls of cellular," according to Steve Markendorff, chief of the FCC Common Carrier Bureau Mobile Services Division's Cellular Radio Branch at IMCE/Fall in Atlanta in September.

"SMR operators have the same capacity today to offer PCS-type services without additional licensing," according to Ralph Haller, FCC Private Radio Bureau chief.

"I'm surprised there isn't more creativity out there now," Haller said. "People (SMRs) aren't doing anything."

NABER hedges support in SMR end-user decision

The National Association of Business and Educational Radio (NABER), Alexandria, VA, supports the FCC's Aug. 5 decision to eliminate, in most cases, separate licensing of SMR system end-users.

The association is concerned about the commission's proposal to have loading data composed of the average number of mobiles and control stations operating on the licensee's system on the first business day of each month for the six-month period immediately preceding the filing of an application.

"We are concerned that the six-month averaging process puts an unnecessary burden on SMR licensees and may lead to customers having to endure an unacceptable lessening of service," said association president E.B. "Jay" Kitchen.

Express yourself

Something bothering you? Want to sound off about it?

Need help that other readers might provide?

Send a letter to:

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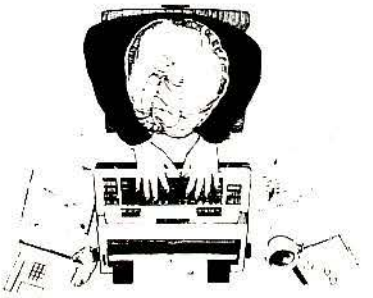
Mobile Radio Technology
P.O. Box 12901
Overland Park, KS 66282-2901



Readers' choice

Of all the new products and services in the April issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Portable radio earphones ensure privacy

The CN series earphones from **T.E.A.** permit users to monitor receive signals with privacy, as well as enable transmissions to be heard in moderate-to-high ambient noise. The earphones plug into most portable radios.

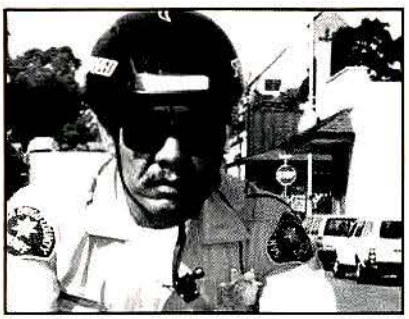
Circle (500) on Fast Fact Card

Coaxial connectors meet commercial applications

The RFX line of coaxial connectors from **Ampenol RF/Microwave Operations** features high quality and low cost. Popular connectors in the line, up to a maximum quantity, are available with a 24-hour delivery time.

Circle (501) on Fast Fact Card

Bicycle patrol headset mic clips to user's shirt



The Fast Comset headset suits bicycle police patrol uses and includes a mic that transmits even a whisper like normal speech. The mic clips to the user's shirt front, and the earphone fits under all bicycle helmets. The **Television Equipment Associates** headset is built to withstand abusive handling inherent in police field work.

Circle (502) on Fast Fact Card

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To continue the design and manufacture of high quality, affordable products for the Land Mobile Radio, Paging and Telemetry/Data markets.

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1974 - 1981: MAXON MANUFACTURERS ELECTRONICS!
Home stereo equipment, citizen's band radios (we are currently one of the two largest manufacturers in the world!) and cordless telephones.

1982: Maxon introduces its first FM two-way business radio, the CP-0510, housed in a compact, "slim profile" case (we patented the case design). This 5 watt, 4 channel VHF portable is the smallest on the market! A full line of accessories were also announced.

1984: Maxon introduces the CP-0520, a UHF version portable. Additional introductions this year — models CS-0510 and CS-0520 (the "CS-Series"), feature a hi-low power switch which selects 1 or 5 watt power output . . . adding a battery saving feature to a Series that still serves the field today!

1986: Maxon enters the telemetry/data market with the DM-0500 Series radio. Three distinct models offer transmit/receive, transmit-only, and receive-only versatility.

1988: Maxon goes synthesized (and mobile)! The SM-4150 is a 40 watt power-house! With 16 programmable channels, and user friendly controls — this mobile will remain a favorite for years to come! Did we mention it took the "Most Innovative New Product" award when introduced to the market?

1991 - 1992:
The SP-2000 Series (models SP-2550 VHF and SP-2850 UHF) synthesized portables offer a 1/5 watt power switch, and 10 programmable channels. This Series performs! The UHF synthesized mobile — model SM-4450 is released. PAGING? YES! The ND Series pagers (models ND-15, ND-45 and ND-90) bring us into another aggressive market. These UHF, VHF and 900 MHz units continue to enjoy strong sales!

1993 and beyond:
Trunking repeaters, trunking portables, innovative LMR products, advanced data and paging products!

References:
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Circle (72) on Fast Fact Card

New products

PC package allows mobile data, E-mail

The PacketCluster computer package features mobile data capability such as real-time messaging, E-mail and remote database access. The **PacketCluster Systems** software runs on a standard 386- or 486-based PC, which serves as the base node. A modem transmits messages over a VHF/UHF radio link or land lines. Customized versions of the package are available to suit specific needs.

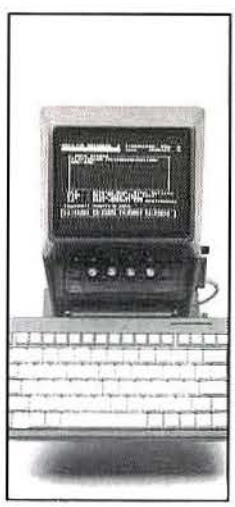
Circle (263) on Fast Fact Card

Tower light monitor boasts automatic dialing

Model 3054 tower light monitor will start dialing three pre-programmed telephone numbers automatically when a tower light burns out. This **Bramco** unit is small and installs easily. Plug into a telephone jack, record a message with built-in mic, program numbers (local or long distance) and connect to "light out" contacts.

Circle (449) on Fast Fact Card

Self-contained PC suits mobile environment



The MDC-890 personal computer from **ElectroCom Communication Systems** features a built-in MDT program for trunking and conventional networks. The self-contained PC includes durable outer case; high-resolution CRT; external floppy disk port and printer port; 80-character by 25-line screen; and a UPS. The system comes with two internal disk drives and supports any PC-compatible software program. The unit's keyboard is removable and adjusts to any angle. An emergency key is on the front panel.

Circle (305) on Fast Fact Card

Cellular channel monitor boasts antifraud software

The Cellscope 2000 system offers cellular radio monitoring and traffic analysis. The **TSR Technologies** system's software has antifraud capabilities that allow service providers or public safety officials to detect cellular phone originations or responses based on a telephone number, serial number or where an individual is calling. More than 1,000 trigger numbers can be set, and an alarm is activated when a target number is transmitted.

Circle (302) on Fast Fact Card

Panel antenna permits field beamwidth adjustment

The SRL-475 panel antenna from **Sinclair Radio Laboratories** allows field adjustment of beamwidth from 49° to 130°. The low profile antenna operates in the 824MHz-to-894MHz range with a 30dB front-to-back ratio. The power rating is 500W.

Circle (257) on Fast Fact Card

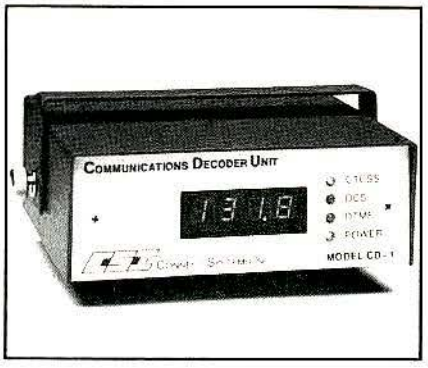
Supplemental power benefits mobile communications

Start-guard provides supplemental power to communications equipment during engine cranking. The **Newmar** unit is wired in-line with the power leads to the equipment, and a set of sense leads are wired to the vehicle ignition. The unit feeds 12V to protect electronic memory and recharges when the engine is running.

Circle (312) on Fast Fact Card

Decoder replays DTMF sequences automatically

Model CD-1 communications decoder from **Connect Systems** decodes and displays 104 DCS codes, 50 CTCSS codes and 16 DTMF digits. The decoder works with service monitors, receivers and scanners. It checks radios and monitors shared repeaters, displaying users' DCS and CTCSS codes, as well as DTMF codes such as ANI, access codes and telephone numbers. DTMF sequences replay automatically in case they were missed the first time or in case the sequence was too fast to observe.



Circle (400) on Fast Fact Card

Circle (61) on Fast Fact Card

Circle (66) on Fast Fact Card

Catalog describes audio accessories

An eight-page color catalog from **Earmark** show its line of audio accessories for communicating in difficult environments. The catalog includes portable and mobile radio VOX accessory devices and features VOX130 technology. One section covers descriptive and technical information on the company's latest interface products, VOXPAK and VOXSET II. Included is a complete description of LOUDMOUTH products.

Circle (413) on Fast Fact Card

Booklet discusses isolator applications

A 12-page booklet titled "An Elementary Introduction to Ferrite Circulators, Isolators and RF Loads" is part of **Tx Rx Systems'** seminar subjects series. It provides information about circulator and isolator operating principles; RF load specifications and ratings; and examples of isolator applications.

Circle (418) on Fast Fact Card

Catalog shows passive RF components

A 41-page component catalog from **Huber+Suhner** covers products such as coaxial adapters, attenuators, detectors, directional couplers, filters and power dividers in an easy-to-read format. Outlines cover important specifications including frequency range, power handling, VSWR and impedance.

Circle (415) on Fast Fact Card

Retail paging stimulates market growth

Retail distribution of paging increases the awareness of paging, according to 90.5% of the respondents to the April 1992 "What Do You Think?" questionnaire. Responses include:

- "Advertising educates consumers to the advantages of pagers."
- "More exposure equals more sales equals more users."
- "It shows the public that the cost of paging is not as high as some thought."

Advantages respondents see in retail distribution include:

- "Brings paging to a whole new market segment."
- "End-user obtains equipment easier."
- "Penetrates consumer market."
- "Prices."

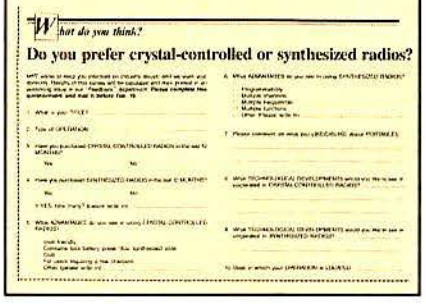
Disadvantages respondents see in retail distribution include:

- "Industry turning into throw-away market with no service needed."
- "It may increase the use of paging for unethical and illegal activities."
- "No price control or standard rate."
- "Places two-way and paging dealers in 'go broke' position."
- "No control over the quality of user equipment."
- "It forces the overall price of paging down, which hurts the small carriers."

Technological developments readers advocate for paging products include:

- "Two-way messaging."
- "Better alpha dispatch systems."
- "Easier access for reaching carrier."
- "Internal ownership in the pagers to cut down on illegal use."
- "Less expensive terminals to deliver alphanumeric pages."
- "Small or portable alpha pager—combo unit."
- "Voice recognition for alpha paging."
- "Voice storage and increased range."

Be sure to fill out this month's "What Do You Think?" questionnaire on page 89 so your responses can be included in a future "Feedback" column.


What do you think?

Do you prefer crystal-controlled or synthesized radios?

People


Fong


Cameron


Hutto


Bantel

Changes at Antenna Specialists, Cleveland:

William Fong leaves Teraoka Seiko, Japan, as regional sales and marketing manager to join Antenna Specialists as managing director for the Asia/Pacific region.

Robert A. Cameron departs Northern Telecom, Research Triangle Park, NC, as assistant vice president of operations for transmission products to become Antenna Specialists' senior vice president of operations.

Changes at Hark Systems, Summerville, SC:

Lizabeth Hutto leaves Dial Page, Asheville, NC, as account executive to join Hark Systems' national sales staff.

Mindy Bantel departs Jazz 101.7 radio station, Charleston, SC, as sales and marketing director to become part of the national sales staff of Hark Systems.

Changes at E. F. Johnson, Eden Prairie, MN, stemming from the sale of the company from Arkla to EFJ Acquisition:

Bill Weksel, a principal in EFJ Acquisition, becomes chairman.

Bob Davies, another principal in EFJ Acquisition, becomes vice chairman.

Michael Kays closes his independent marketing consultancy in Minneapolis to become E. F. Johnson's senior vice president of marketing.

Exiting the company are **John Somrock,** president; **Joe Eastman,** vice president of human resources and administration; and **Kathy Papski,** vice president of finance.

Changes at Ericsson GE Mobile Communications (EGEMC), Lynchburg, VA:

Ronny Lejdemalm, the head of Ericsson Business Area Communications, Stockholm, transfers to become EGEMC president and relocates to the company's facilities in Research Triangle Park, NC. Lejdemalm succeeds **Ake Lundqvist,** who retires as EGEMC president and remains on the board of directors of Ericsson, Stockholm.

Ake Persson returns to EGEMC as business development vice president after spending nearly two years on special assignment to RAM Mobile Data, New York, as executive vice president of business development.

Leif Holm, EGEMC vice president, moves up to become president of Spectrum Ericsson, Woodbury, NY, a radiopaging and voice messaging systems manufacturer. Holm replaces **Edward J. Mulvey,** who resigned.

Calendar

1992

November

12-15—Communications Marketing Conference, John Ascauga's Nugget Hotel, Reno, NV. Contact: Gene Johnson, Vega Signaling, 818-442-0782.

20—Radio Club of America Awards Banquet, New York Athletic Club, New York. Contact: 201-652-6811.

1993

January

25-26—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Sheraton, New Orleans. Contact: 202-331-7773.

March

3-5—Cellular Telecommunications Industry Association Winter Meeting and Exposition, Dallas Convention Center, Dallas. Contact: 202-785-0081.

17-19—Western States Regional Conference Associated Public-Safety Communications Officers Meeting, Hyatt Regency, Phoenix. Contact: Deborah L. Overton, 602-256-1029.

21-24—Energy Telecommunications and Electrical Association, New Orleans Convention Center, New Orleans. Contact: 214-235-0655.

23-25—International Mobile Communications Expo/Spring, Anaheim Convention Center, Anaheim, CA. Contact: 303-220-0600.

April

19-22—Supercomm and Telocator Spring Conference, Georgia World Congress Center, Atlanta. Contact: 800-326-8638.

21-23—North Central Regional Conference Associated Public-Safety Communications Officers Meeting, Radisson Inn Bismarck, Bismarck, ND. Contact: Lyle V. Gallagher, 701-224-2127.

May

12-14—Annual Mobile Communications Conference, sponsored by the National Association of Business and Educational Radio (NABER), Hyatt Regency Hotel, San Antonio. Contact: NABER, 800-759-0300.

17-20—East Coast Regional Conference Associated Public-Safety Communications Officers Meeting, location and chairman to be announced.

18-20—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Meadowlands Hilton, Secaucus, NJ. Contact: George D. Graul, 908-290-1128; fax 908-290-1932.

26-28—RadioComm, Metro Toronto Convention Centre, Toronto. Contact: Lisa La Prairie, 613-233-4888.

June

29-July 1—Utilities Telecommunications Council Annual Meeting, San Antonio Marriott Rivercenter and Convention Center, San Antonio.

July

18-22—Forestry-Conservation Communications Association, Jackson, WY. Contact: Don Pfohl, 602-644-3166.

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- Technology Project Management
- Telephone Systems Analysis
- Data Network Design
- GeoBased Systems

5950 CANOGA AVENUE, SUITE 600
WOODLAND HILLS, CALIF. 91367
(818) 710-8855 • FAX (818) 710-1467

PORTA-TECH
PORTABLE TECHNICAL SERVICE, INC.
1106 Laxton Road • Lynchburg VA 24502
GE Portable Radio Service Depot
Factory Approved Nationwide
FACTORY TRAINED TECHNICIANS FOR QUALITY SERVICE
- Current Product Lines
- Voice Guard Certified
- Public Service Trunking
- Surface Mount Technology

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Classified

Advertising rates in **Mobile Radio Technology**'s Classified Section are $69.00 per column inch, per insertion, with frequency discounts available. There is a one inch minimum.

Ads larger than one inch are sized in ¼-inch increments and billed accordingly, as determined by total size of the ad, including ruled borders and rounded up to the nearest ¼ inch.

Blind box ads (replies sent to **MRT** for forwarding) are $30.00 and Fast Fact reader service numbers are available for $25.00 per service, per insertion, to cover processing and handling costs.

Optional color, determined by **MRT** on an issue-by-issue basis, is available at $150 per insertion.

A prepayment discount of 5% is available for all 6x or larger frequency classified advertisers who prepay their full 12 month schedule.

No agency discounts are allowed for classified advertising.

Contact Carla Gamino at (303) 792-1249 or fax (303) 792-0069 to place your classified ad. Or send your advertising materials and order to Lisa Cunningham, **Mobile Radio Technology**, Classified Advertising Department, 9800 Metcalf, Overland Park, KS 66212.

Equipment for sale

LAND MOBILE RADIO BBS
Buy - Sell - Trade used radio equipment with hundreds of other dealers nationwide. Call with your modem to register now.
The CommLine BBS
313-854-6441

ICOM SPECIAL
H16a 16 channel VHF
Scanning Handhelds $515
ICOM Marine & Aviation in stock
Nationwide Paging Service Available
call XPM (512) 693-4999

MOTOROLA EQUIPMENT FOR SALE
10—Syntor UHF 110 Watt DPL • 10—MCX-100 VHF 30 Watt Multi Freq. • 8—PAC RT Mobile Repeater • 4—Radius 42-50 60 Watt • 5—Radius M100-M216 VHF UHF-LB 110 Watt MITREKS • 800 Conv MAXAR 80's MINT • 4—Mot Syntor X-9000 UHF 64 Freq. • 5—Mot 900 MHz Trunked Rptrs. • 5—Mot 800 MHz Trunked Rptrs. • 1—Mot B84CB6106AT UHF 150 Watt w/duplexer "AS NEW" • VIIF/UHF MSR-2000 & MSF-5000 • 1—900MHz UHF Motorola Purc page stations • 1—LB Micor Rptr. w/duplexer 110 Watt • 3—Mitrek Consolette Base VHF/UHF • 8—MT-1000's VHF UHF 16/99 ch. • Assorted Radius P-100/P-200 VHF/UHF • 5—Mot Expos VHF "NEW" w/Rapid Batt & Chargers • HT-440's HT-90's VHF/UHF MT-500's Saber I, II, III (with encrypt.) • Mot Centracom II Controller •
SCOTT COMMUNICATIONS
406-745-3218

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Direct all correspondence to our P.O. Box.
P. O. Box 7846 — **Fredericksburg, VA 22404** — **(703)373-3888**

Programming for MCX100, Syntor, Syntor X, and MX's Available

H43SXU1140 & 3140 6w VHF MX's DES
H44SSU3140 4W UHF MX's PL
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Mitrek Accessories, SYS 90, Sel Call; ACM; Scan & Siren Available
MCX100 DES Scan 10W 148-174
C71RCB3146 100W C.D. 36-42 PL Dual RX
C42RCB3105DA 25W C.D. 72MC PL Rptr
Q1002 Micor Suitcase VHF Base
C53RTB3125 60W PL 150-162 DC Control
C73RTB1106 100W CS or PL 142-150 & 150-162 MC
MBX Brief Case Base 30W 12F DES VHF
C73RXB1106 100W C.D. DES Rptr. w/duplexer
L44JJB3100AM Mitrek Consolette
Martis EMS Base & ER Console
Q2208 DES Comparators w/5 SQM's; 5 Aux. SQM's
Command; Tone key; Logic Modules
Spectra Tac RX's CS LB & VHF
RCA Votec Comparator & Receivers
RTX4007; TEK5 & MORE

Circle (90) on Fast Fact Card

Equipment for sale

Swersweep
SWR Measurement Kit

Swersweep is designed to work with modern service monitors with tracking generator and spectrum analyzer enabling a plot of SWR vs. Frequency on the CRT display. Swersweep allows the instrument to function as a scalar network analyzer. See feature article on page 64 of October 1989 *Mobile Radio Technology* for more information.

Uses:

- Tuning Antennas. Base, mobile, or glass
- Tuning cavities, duplexers, or filters
- Tuning preamps and Receiver front ends
- Checking transmission line and trimming to resonance

Each Swersweep is hand built with calibration traceable to the National Bureau of Standards.

1-500 Mhz. $350, 1-1000 Mhz. $675

Prices include shipping

Europa Marketing
2358 S. Patterson Mesa, AZ 85202
Phone: 602-345-6666

New Device Forwards Calls to SMRs

Your SMR users can now be reached by the people who need to find them – without the hassle of overdialing.

New ***LOGOS*** provides selective call forwarding from a land line to any phone number – anywhere. The caller simply calls the SMR user's office number as usual and ***LOGOS*** will forward all incoming calls to the SMR, or forward only those callers who know the VIP touchtone code.

Compatible with SMRs, roaming cellular, private interconnects, paging and wireline systems, with or without overdial.

- Inexpensive. No monthly fee.
- Modular plug-in installation. All solid state.
- Requires only one phone line equipped with 3-way calling and DTMF signalling.
- User can reprogram ***LOGOS*** from any DTMF phone anywhere following simple voice prompts.

Call now for details:
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Made in U.S.A.

Logotronix™

Logotronix Communications LLC, 12421 Washington St., Thornton, CO 80241

Dealer inquires invited.

Circle (80) on Fast Fact Card

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Specializing in MOTOROLA NEC UNIDEN

Precision crystals at affordable prices.

Common frequencies for popular pagers in stock.
Custom order and specialty crystals welcome.

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MIDLAND • GE • RANGER • STANDARD • UNIDEN

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Radius®

Mobiles
Portables
Bases
Accessories

SUPER PRICES!
We BEAT
all others!

Call us LAST!

Orders 800-231-0103
Questions 303-249-1414
FAX 24 hr. 303-249-4334

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Montrose, COLORADO 81401

Custom Made Voting Receivers

MIDLAND LMR LAND MOBILE RADIO

Wtalkback For G.E., Motorola & RCA Comparators

*Low Band
*High Band
*UHF Band
*Dealers Only
*Same Day Shipping On Mobiles & Portables

LARGE INVENTORY OF MOBILES & PORTABLES

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Circle (82) on Fast Fact Card

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at Low Prices!

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- PORTABLES
- MOCOM 70
- MAXAR
- RPTRS
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- ACCESSORIES
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Large Quantities • (817) 433-5452

Classified

Equipment for sale

Equipment for sale

Circle (84) on Fast Fact Card

Circle (85) on Fast Fact Card

Circle (86) on Fast Fact Card

Equipment for sale

Equipment for sale

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• Lifetime Guarantee on Bomar Crystals • Competitive Pricing
• 48 Hour, 1 Week and 2-3 Week Service

Call 800-526-3935 • Fax 800-777-2197

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Circle (91) on Fast Fact Card

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Made to your exact specifications and frequencies.

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We ship prepaid net 30 days.

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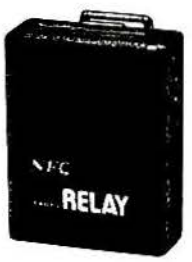
Cave Creek, Arizona 85331



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Stocking common RCC & PCP frequencies
Quantities are Limited

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Blytheville, AR 72315
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Micor Base/Repeater	from $1295
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Mocom 70 Consolets	from $250
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Mitrek Mobiles	from $150
Maxar, Radius, Traxar Mostars	from $150
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EX II Mobiles	from $100
Phoenix/Centura/MVP	from $150
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Bob Barnett
Owner — W5RHL
FCC 1st Class Tech
30 Years in Communications

Bases/Repeaters/Mobiles
No Used Pagers-Portables or Parts
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Call For Quote or Sales List
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BARNETT ELECTRONICS
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Call Sid Cohen
at AIR COMM—Phoenix, AZ
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30%-70% savings on Motorola, GE, EFJ mobiles, base stations, portables, pagers, repeaters—primarily solid state—all frequency bands. Also, accessory items: Motorola "**Systems 90**" control heads, **PL and paging reeds**, channel elements. Cash quotations made for purchase of above equipment.

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Console components
BOUGHT & SOLD
Telecommunications
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Ph: (415) 871-4200

Circle (92) on Fast Fact Card

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Mot. MSF5000 AS NEW!!
110 W. UHF Continuous
w/TONE REMOTE!
800-231-0103 California Radio
$4975.

TOUCH-TONE DECODER/DISPLAY & ASCII CONVERTER BOARD

Model TDD-8 decodes and displays all 16 DTMF digits. Digits are displayed on eight LED's. 32 character memory can be scrolled. It will accept almost any audio source. Ideal for remote DTMF control or data entry using a telephone keypad. ASCII serial output can be connected to your computer. IBM compatible software included for displaying, storing and/or printing time, date and number for automatic logging.

TDD-8 DTMF DECODER/DISPLAY/ASCII	$99
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PS-12 110VAC TO 12VDC POWER PACK	$10

add $5 S/H - VISA/MC ACCEPTED

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Eugene, OR 97402 **FAX: (503)-687-2492**

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CRYSTALS FOR ALL RADIOS

☐ **Communication Crystals**
☐ **Channel Elements**

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CALL OR FAX FOR QUOTE

Ranger VHF 110W w/S550 scan	$650
Micor UHF T44RTA3803A w/sys 90	65
MAXOR 80 42-50 55 W. PL/Ext	115
AEROTRON 460MHz syn. mobile	95
CUSTOM MVP 800 MHz Radio only	100
CUSTOM MVP, VHF w/acc	125
MVP HOUSING PANELS PARTS KITS	call
Delta-S 150-174 no. acc. 110W	275
Delta-S 450-470 40W S-990 acc.	350
Delta-S Low band and "T" band	Call
VHF PLS Port. 16 ch w/GESTAR	225
PLS/MPD/MPA Multi-chrgr, new	125
Phoenix-SX 406-430 16 ch. new	225
MASTR II 150-174 110W	from 115
MASTR II mobile cables	20
MASTR II VHF "E" package, 110W DFE W/C-500 scan accessories	150
S-990 128 ch. head w/warranty	125
NEW CELLULAR HANDSETS & Options	call
MPS/MPR/MPX/MPI/MPD Chargers	call

NEW LONDON TECHNOLOGY
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Equipment for sale

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For Two-Way Radios and Cordless Telephones

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For a distributor nearest you, please call
Toll Free 800-228-4563; or toll free fax 800-848-DUCK (3825)

CENTURION INTERNATIONAL, INC.
P.O. Box 82846 ■ Lincoln, NE 68501

Circle (95) on Fast Fact Card

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LAND MOBILE RADIO — Nationwide

Factory Approved
WHOLESALE PRICES — **Dealers Only**

- *Large Inventory • Fast Service • Flat Rate Repair Service*
- *Complete Dealer Support Program*

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(612) 869-2487

SAME DAY SHIPPING
Call for Weekly Specials!
Refurbished Equipment Available

FAX (612) 869-3078

RCW DISTRIBUTING
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MPLS, MN 55423

Circle (96) on Fast Fact Card

STOP AND SAVE!

MOTOROLA RADIUS
End users shop first then call for best price.

Procomm
805-497-2397

THIS MONTH'S SPECIALS

P50s AS LOW AS $210.00 CWO — P200s AS LOW AS $450.00 CWO
HEAVY DUTY MICS $50.00 — DTMF $110.00

WANTED USED RADIUS EQUIPMENT

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Sign up now for FREE used equipment bulletins and HOT SPECIALS via FAX.

VersaTel Ph: 1-800-456-5548 Fax: 1-307-266-3010

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Used Duplexers
Also repair & retuning.
You don't pay if it won't tune.
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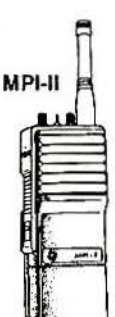
CALL: 1-800-727-5657

Your Complete GE Distributor

PCS

Mobile Communications

MPI-II



distributed by
Communications Associates Inc.
(800) 435-9313 In Illinois (800) 892-1611
Order Fax (800) 284-4934

Circle (98) on Fast Fact Card

ACTIVE FILTERS
AND
REEDS
FOR MOTOROLA PAGERS
FAST DELIVERY

Bramco

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- Standard HX300 VHF & UHF
- Standard HX400 VHF & UHF
- Uniden SPH & SPU
- Standard GX3000 VHF & UHF
- GE MLS & Phoenix VHF & UHF

VersaTel Ph: 1-800-456-5548 Fax: 1-307-266-3010

BUY
SELL
Used GE-MARC
Trunking Radios.

TMX 8310 TMX 8210
TMX 8510 TMX 8712
TMX 8825 TMX 8615

Call John Peacock
Tel. 800-232-7715
Fax 501-735-7799
New & Used Equipment Available

CLEAN MOTOROLA RADIOS

MOBILES & PORTABLES 800 MHZ TRUNKED	
15W MOSTAR W/MIC BRACKET & POWER CABLE	$ 395
15W MAXTRAC W/ACCESSORIES	$ 495
15W MAXTRAC B7 10 SYS. SCAN, TALKAROUND	$ 595
35W MAXTRAC B7 10 SYS. SCAN, TALKAROUND	$ 695
35W SYNTOR X2 OR X3	$ 250
35W SYNTOR X15 SYS/15 SUB/TALKAROUND NEW	$ 995
35W SPECTRA B5 10 SYS/SCAN/TALKAROUND	$ 995
25W PP1000X $ 995 PP500 X	$ 695
2W MTX800 $ 595 MTX810 6/SYS/CONV	$ 895
3W STX W/DTMF SCAN	$1,095
3W STX SMARTNET 1 & 11 GEMINI	$1,895
BASE STATION PACKAGE P/S, DESK MIC	$ 200
MOBILES & PORTABLES 900 MHZ TRUNKED	
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12W B5 SPECTRA 10 SYS/10 SUB/SCAN/CONV	$ 695
30W B5/B7/B9 SPECTRA 10 SYS/SCAN/TEL	$ 995
30W L37VL8 BASE W/3 REMOTES	$1,495
2W MTX900 B3 & B4 6 SYS/3 SUB/CONV	$ 995
CONVENTIONAL RADIOS	
110W VHF MITREK 4F PL/DPL ALL ACC'S	$ 395
100W UHF MITREK 4F PL/DPL ALL ACC'S	$ 495
100W UHF SYNTOR X 8F W/DIR MINT	$ 795
100W UHF MICOR 12F PL W/S	$ 295
60W VHF MITREK 4F PL/DPL	$ 295
40W UHF SPECTRA 450-482 MHZ A3 TRNK MINT	$ 995
45W VHF SPECTRA A3 99 MODES	$ 995
30W 900 MHZ SPECTRA "A5" SCAN	$ 595
60W LB MAXTRAC 2F 30-36 MHZ	$ 350
25W UHF MAXTRAC 16F	$ 425
N1244 CONVERTA-COM W/12W SPKR & MIC	$ 125
MT500 VHF/UHF PL	$ 150
4W UHF OR 5W VHF HT600 6F	$ 445
4W UHF HT50 2F	$ 325
6W VHF SABER 11 DVP CAP NEW IN BOX	$1,095
6W VHF SABER 111	$1,395
5W UHF SABER 111	$1,495
4W UHF GP300 2F W/CHRGR	$ 395
SYSTEMS 90 ELECTRONIC SIREN MICOR/ MARATRAC	$ 50
23 Ghz STARPOINT TELEMETRY 23 AT	$1,500

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WE BUY STX · MTX · MAXTRAC · MT1000 · SABER
MOSTAR · SYNTOR 9000 · SPECTRA · HT600
LOWEST RADIUS RADIO PRICES IN USA · GUARANTEED
GP300 8F W/CHRGR $499 P110 $352 M100 $314
RADIO EXPRESS INC 703-256-1928 FAX 703-830-8710

Circle (97) on Fast Fact Card

Classified

Equipment wanted

Equipment Wanted
Motorola, Johnson, GE,
EFJ, Uniden, Standard
Buy-Comm-Co.
1-800-347-4121
FAX (602) 585-6900

• PAGERS • PAGERS • PAGERS •
WANTED TO BUY PAGERS
McManus Communications
Phone: 501-763-6250
Fax: 501-763-6533
• PAGERS • PAGERS • PAGERS •

Motorola/Radius Upgrades and Conversions
GP-300 16 Channel Kits
• Complete kit $44.95
Standard Programming and Repairs also available
RadMax Communications
COMPLETE COMMUNICATIONS SERVICE
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Make your classified ad stand out. Use color!

Position wanted

FCC LICENSED PAGING TECH
13 years RF exp. 9.5 years paging
desires RF MGMT.
POS. US, EUROPE, ASIA
FAX 818-505-0627

Invest your Advertising Dollars where your Prospects Invest their Time...
MOBILE RADIO TECHNOLOGY

Help wanted

RADIO TECHNICIAN
5 years experience in Motorola and Ge radio equipment. FCC or Naber license required. 27,000-35,000/yr., depending upon experience. Moving expenses paid and health insurance plan. Send resume to:
Comm Tech
P. O. Box 2712, Elko, NV 89801

OREGON / WASHINGTON
Looking for experienced salesperson willing to move to the beautiful Pacific Northwest. Must have 2-way radio experience. Only those with radio sales background need apply. Equal Opportunity Employer. Send resume to:
Personnel Manager
P.O. Box 22169
Milwaukie, OR 97222

LOOKING FOR INDIVIDUALS WITH EXPERIENCE OR AN INTEREST IN THE DESIGN, MANUFACTURE AND APPLICATION OF R.F. FILTERING EQUIPMENT.
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TEL: 602-581-2875

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National openings for experienced Cell Site Techs, Switch Tech, and other TECHNICAL PERSONNEL at all levels within Cellular Communications. Locations in a number of markets.
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215-783-5400; 215-783-6008 (FAX)
COMMUNICATIONS RECRUITMENT SINCE 1957.

TWO-WAY RADIO TECHNICIANS
Growing Motorola Service Shop, in the beautiful Pacific Northwest needs qualified and experienced two-way radio technicians. Minimum 2 years experience servicing major brands. Must have strong employment history and FCC Certification. Excellent wages and fringe benefits. Equal Opportunity Employer.
Send resume to:
Clackamas Communications, Inc.
Attn: Gordon Day, P. O. Box 22169
Milwaukie, OR 97222

PageNet, the largest paging company in the U.S., has aggressive plans for continued growth nationwide. Currently, we have opportunities for qualified professionals to participate in the expansion and maintenance of our state-of-the-art paging network. **Openings exist in various cities throughout the U.S. for the following:**

Systems Manager
In this position, you will have responsibility for the design, engineering, construction and continued growth and reliability of the complete paging system. We require a working knowledge of paging systems and/or RF transmitters; experience managing technicians is a plus. ***Dept. SM-MRT.***

Systems Technician
You will have reponsibility for installing and maintaining base stations and paging terminal equipment. At least 1 year experience with paging or two-way FM transmitters is required. ***Dept. ST-MRT.***

We offer competitive salaries and a full range of medical and other insurance benefits. Qualified applicants should send resume with salary history and requirements, ***indicating appropriate department code,*** to: **Paging Network, Inc., 4965 Preston Park Blvd., Suite 500, Plano, TX 75093.**

PAGENET

Equal Opportunity Employer
No Phone Calls Please
Principals Only

MANAGEMENT
Growing Motorola Service Shop, located in the beautiful Northwest, is seeking candidates who demonstrate understanding of principles & practices of Two-Way Radio Repairs and Installations. Must have a minimum of 3 years management experience and be highly motivated; people oriented; well organized and able to work under pressure. Excellent benefits and competitive wage. Equal Opportunity Employer. Send resumes to: Clackamas Communications, Attn: Gordon Day, P.O. Box 22169, Milwaukie, OR 97222. No phone calls please.

COMMUNICATIONS TECH
Progressive Communications Company looking for Tech with 2-Way background. Proficient with GE, Motorola, E.F. Johnson and LTR Trunking. License or Certification a plus. Excellent salary and benefits, EOE. Send resume to Service Dept.
Gila Communications, Inc.
1421 S. 20th Ave., Safford, AZ 85546
602-428-3564

Business Opportunity

BUSINESS FOR SALE
Motorola Service Shop
13 yrs. of established business success
2 mountain top sites
Paging System - Company Owned
Cellular Phones
Sales & service of all major brand comm. equip.
Located in So. West Wyoming
85 miles from Salt Lake City, Utah
CALL JUDY **307-789-2058**

Help wanted

COMMUNICATIONS SUPERVISOR

The Missouri Department of Conservation is accepting applications for a Communications Supervisor who manages statewide telecommunications and two-way VHF radio systems, including system design and equipment/tower site installation and maintenance. Position is located at the Central Office in Jefferson City, Missouri. Maintains FCC license currency for 200 fixed radio stations, approves expenditures for communications equipment and services, manages rental contracts for tower sites, prepares budget requests, and maintains communication with state and federal agencies. Supervises nine technicians and seven maintenance facilities.

Graduation with a Bachelor's degree in electronics, engineering, computer science or related subjects and five years of experience in two-way radio/telecommunications system managment, at least one year of which must have been in a supervisory capacity, or an equivalent combination of education and experience. Basic computer knowledge required.

To apply, call 314-526-4497 or 314-751-4115 between 8:00 a.m. to 12:00 noon or 1:00 p.m. to 5:00 p.m. by November 13, 1992.

Missouri Department of Conservation
Human Resources Division
P.O. Box 180
Jefferson City, MO 65102

Equal Opportunity Employer M/F

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York, PA 39 56 30N; 76 41 55W
180' Rohn 13-6N8 866HAMSL
Deal Direct for Reasonable Rates!

Robert W. Brandick
1018 E. Philadelphia St., York, PA 17403-1123
717-845-4996 (1-9 PM)

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Southcentral Pennsylvania
Mt. Holly Summit 40 05 52N; 77 12 12W 1685'
High Rock Summit 39 51 47N; 76 57 01W 1335'
Deal Direct for Reasonable Rates!

Robert W. Brandick
1018 E. Philadelphia St., York, PA 17403-1123
717-845-4996 (1-9 PM)

TEL: (708) 823-7713

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STAN STANN

COMMUNICATIONS TOWER & ANTENNA SITES FOR THE METROPOLITIAN CHICAGO AREA

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CHICAGO IL 60631

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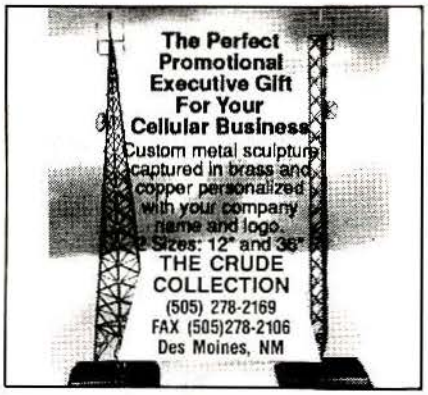

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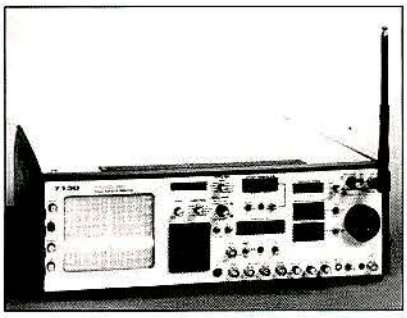

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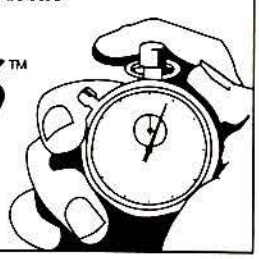

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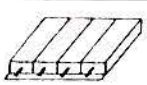

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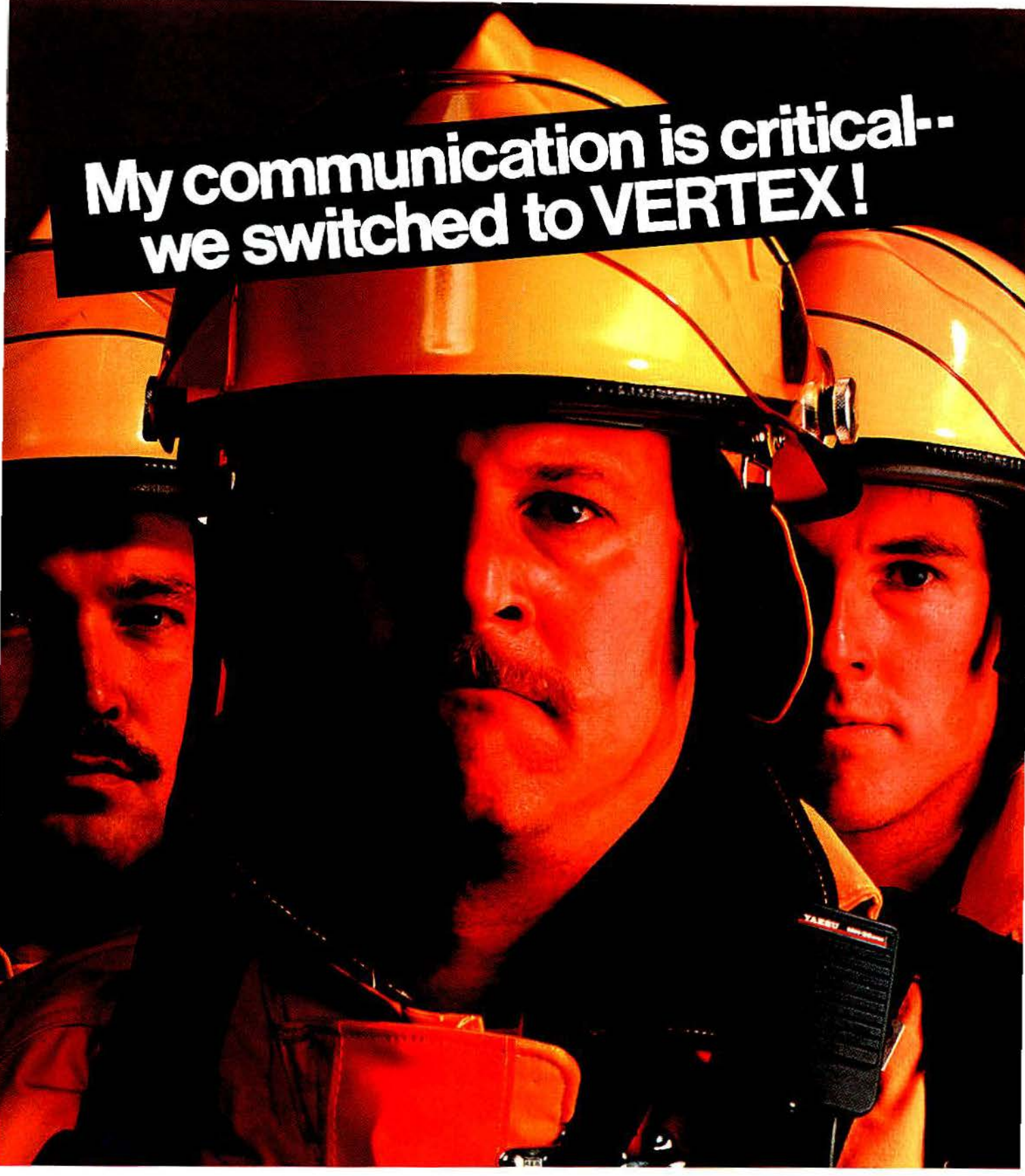

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